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SAMPLING A GOLD-COPPER DEPOSIT, GOLDEN ZONE MINE, SOUTH-CENTRAL ALASKA

by J. J. Mulligan, R. S. Warfield, and
R. R. Wells

* open-file report

UNITED STATES DEPARTMENT OF THE INTERIOR

Stewart L. Udall, Secretary

BUREAU OF MINES

Walter R. Hibbard, Jr., Director

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SAMPLING A GOLD-COPPER DEPOSIT, GOLDEN ZONE MINE, SOUTH-CENTRAL ALASKA

by

J. J. Mulligan,[1] R. S. Warfield,[1] and R. R. Wells[2]

ABSTRACT

The Bureau of Mines channel sampled and diamond drilled the Golden Zone mine and nearby gold-copper deposits in 1950 and 1951. Difficult drilling conditions made sampling costs prohibitive; the work had to be stopped before enough data was obtained to estimate recoverable reserves. The Golden Zone mine is near the southwestern end of a northeast-southwest-trending belt of complex sulfide deposits, about 6 miles long, straddling the West Fork of the Chulitna River in the Healy quadrangle, South-Central Alaska (fig. 1). The deposits are related to small diorite and diorite-porphyry stocks and dikes which intrude complexly interlayered sedimentary and volcanic rocks. Gold and silver, associated with arsenopyrite, pyrrhotite, chalcopyrite, sphalerite, and galena occur in altered zones in and along fractures, contacts, bedding planes, and other openings in the intrusives and the surrounding sedimentary and volcanic complex. The Golden Zone deposit is in fracture zones within a diorite-porphyry stock; the ore ranges

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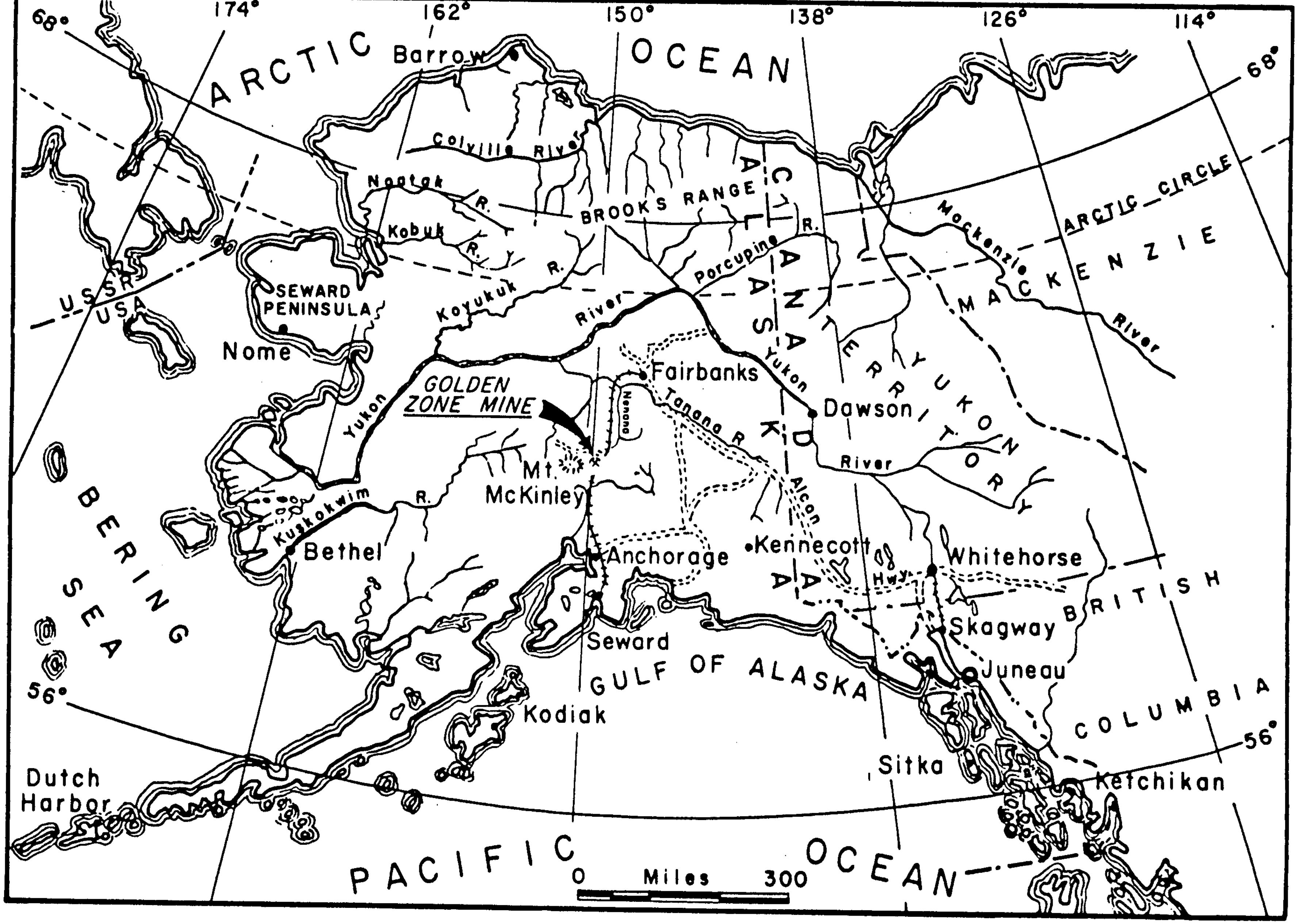


FIGURE 1. - Index Map of Alaska

in value downward from about $10 or $12 per ton. Most of the gold and sulfide minerals appear to occur in fracture fillings or along the fractures. The company planned to upgrade the ore by rough crushing, followed by grinding, screening, and discarding the tough unfractured diorite oversize with no further treatment. Preliminary metallurgical tests by the Bureau were not on a large enough scale to determine whether or not the company's milling plans were efficient, but do indicate that a good recovery of copper, gold, and silver can be made by standard flotation methods. However, the abundant arsenopyrite in the resultant concentrates must be removed to avoid penalties or possible refusal by smelters.

The Golden Zone mine, in 1941 and 1942, produced 869 tons of bulk flotation concentrate containing 1,581 ounces of gold, 8,617 ounces of silver, and 21 tons of copper, but was forced to close in 1942 and has not reopened.

INTRODUCTION

The Federal Bureau of Mines, in 1950 and 1951, investigated the Golden Zone mine, a gold-copper deposit in South-Central Alaska. The objective was to estimate both the amount of gold and the amount of recoverable copper and other base metals associated with the gold. If substantial base metal recovery could be expected, it was planned to explore extensions of the deposit and nearby related occurrences to determine the size and grade of the reserves.

The investigation included a study of the company sampling and recovery records, followed by check sampling, diamond drilling, and metallurgical testing by the Bureau of Mines. The Bureau's check sampling roughly agreed with the company data, but diamond-drill exploration proved to be impractical. The nature of the deposits and the country rock made sample evaluation doubtful and drilling costs prohibitive. No other means of sampling were available; the investigation had to be stopped without achieving conclusive results. Preliminary metallurgical tests were made, but this phase of the program was abandoned when it proved impractical to estimate reserves. The investigative program, however, did result in compilation of a considerable body of information that has been incorporated into this report.

ACKNOWLEDGMENTS

This report was made possible through the cooperation of Mr. W. E. Dunkle (since deceased), president of Golden Zone Mine, Inc., who furnished mine maps, sample analyses, and operational data. Also acknowledged are the many courtesies extended by Mr. W. H. Greene, owner of the adjoining Mayflower claims.

Diamond-drill cores were logged by geologists of the Geological Survey. Geological Survey maps and publications were a principal source of historical, geographical, and geological data; the publications dealing with this area are listed in the bibliography.

The Alaska Road Commission (now Bureau of Public Roads) repaired the access road and permitted the Bureau to use available transportation equipment. The Alaska Railroad management and employees also were most cooperative; use of their transportation and communication facilities was particularly valuable during periods of emergency.

LOCATION AND ACCESSIBILITY

The belt of gold-bearing sulfide deposits, which includes the Golden Zone mine, is in the southern foothills of the Alaska Range 2 to 6 miles south of Mt. McKinley National Park, near the southwest corner of the Healy quadrangle, in South-Central Alaska (fig. 2). The belt straddles the West Fork of the Chulitna River and extends from Costello Creek to Long Creek, a distance of about 7 miles (fig. 3). The Golden Zone mine is in the southwestern part of the belt near the head of Bryn Mawr Creek.

The usual means of access is via The Alaska Railroad to Colorado Station (mile 297), then by gravel road 12 miles to the Golden Zone mine. A branch of this road, extending northward about 4 miles to the Dunkle coal mine, gives access to the northern end of the belt. The road was built and maintained by the Alaska Road Commission, but with the cessation of mining activity, maintenance was discontinued. A long wooden trestle over the West Fork of the Chulitna River probably is no longer usable, but the river can be forded during periods of low water. The stream is of glacial origin and the volume of water fluctuates widely.

Snowfall in the area is heavy but snow removal should present no unusual problems in the section of road where the heavy growth of trees minimizes drifting. The last 2 miles of road to the Golden Zone mine is not sheltered by timber and is subject to continual drifting.

The area is accessible by air via bush planes from either Summit (16 miles northeast), Talkeetna (65 miles south), or Anchorage (140 miles south). During the summer, light wheel-equipped planes can land at Colorado Station or on a gravel bar on the West Fork of the Chulitna River about 3 miles

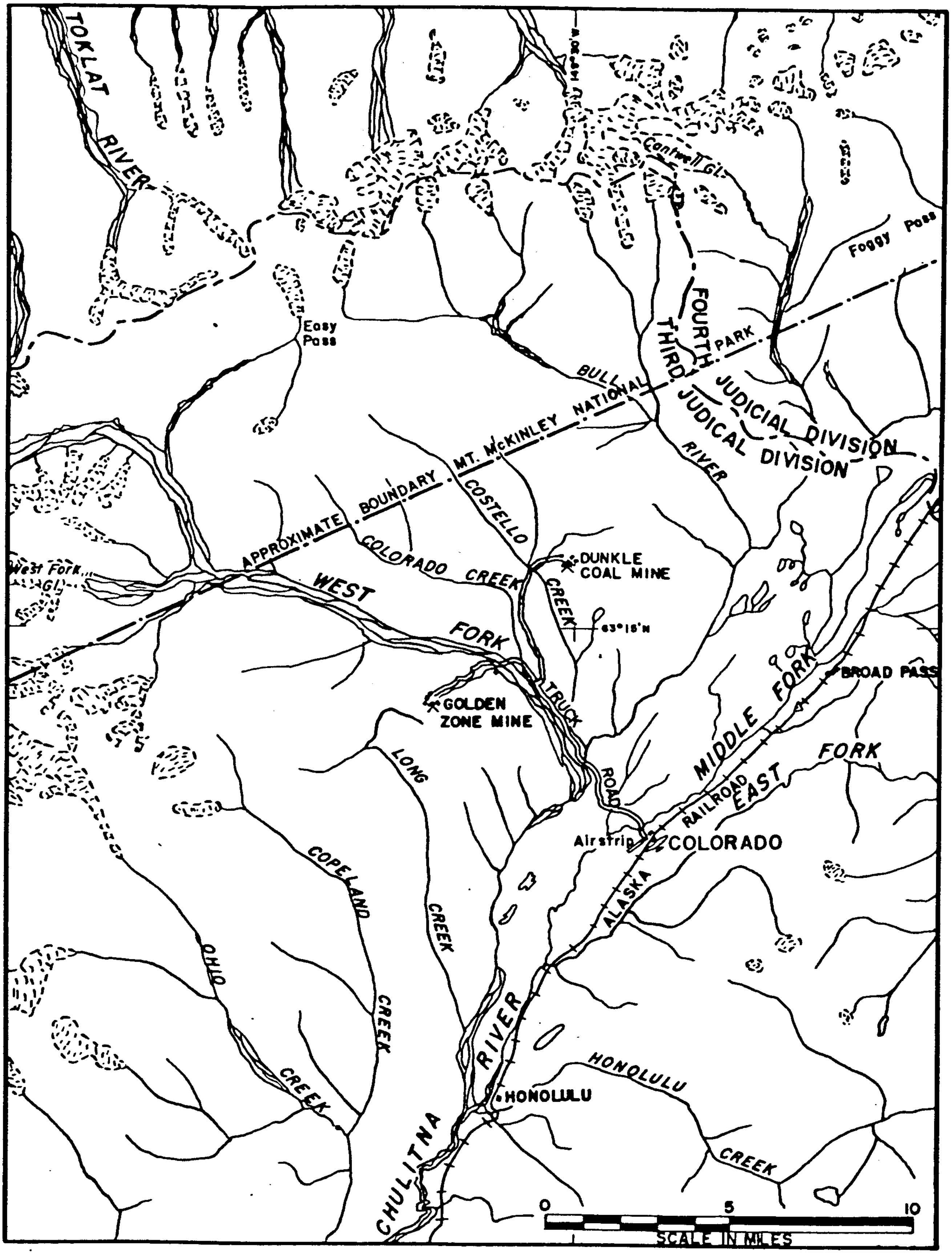


FIGURE 2. - Golden Zone Mine, Upper Chulitna Area.

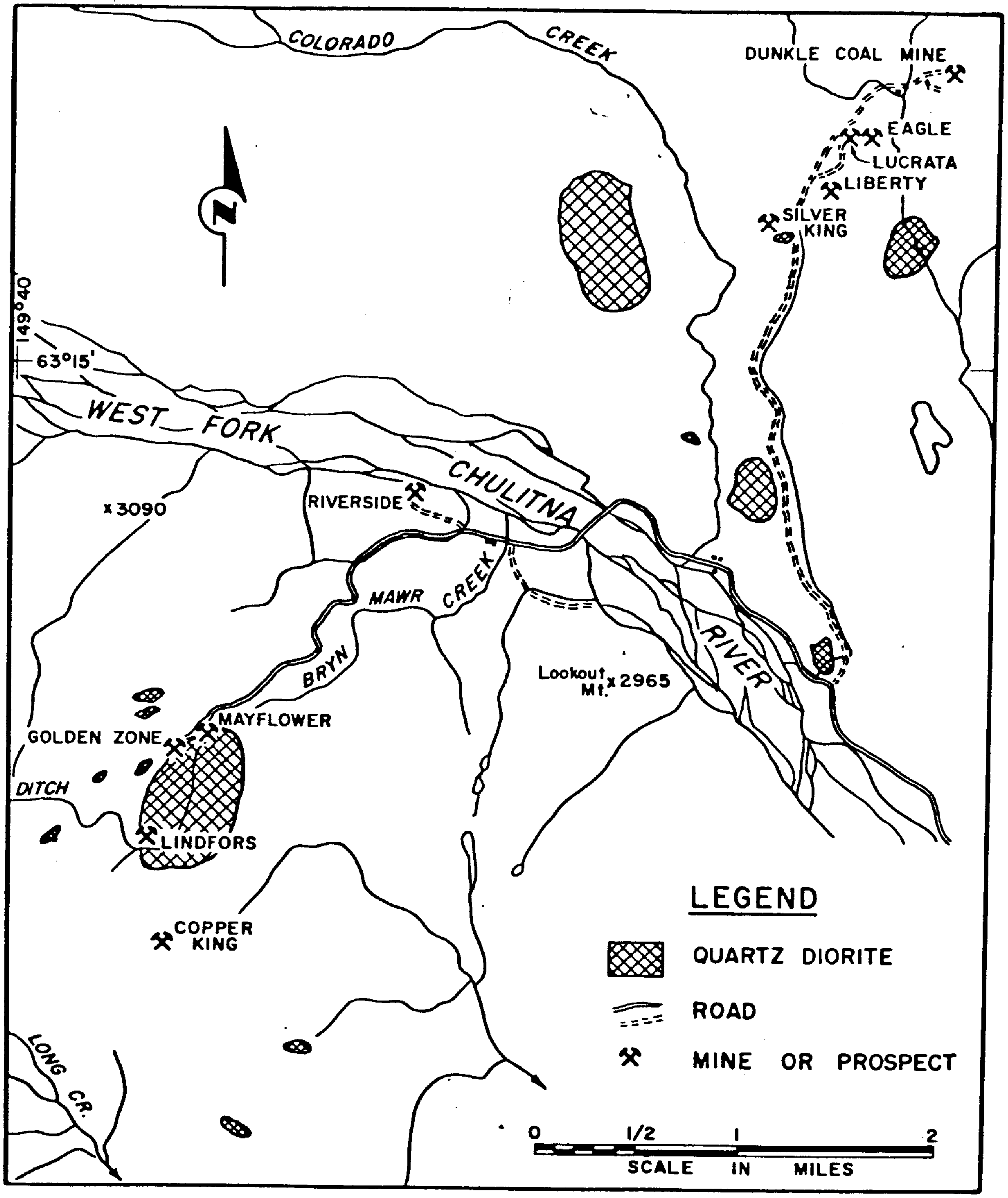


FIGURE 3. - Geologic Map, Golden Zone Mine and Other Nearby Prospects.

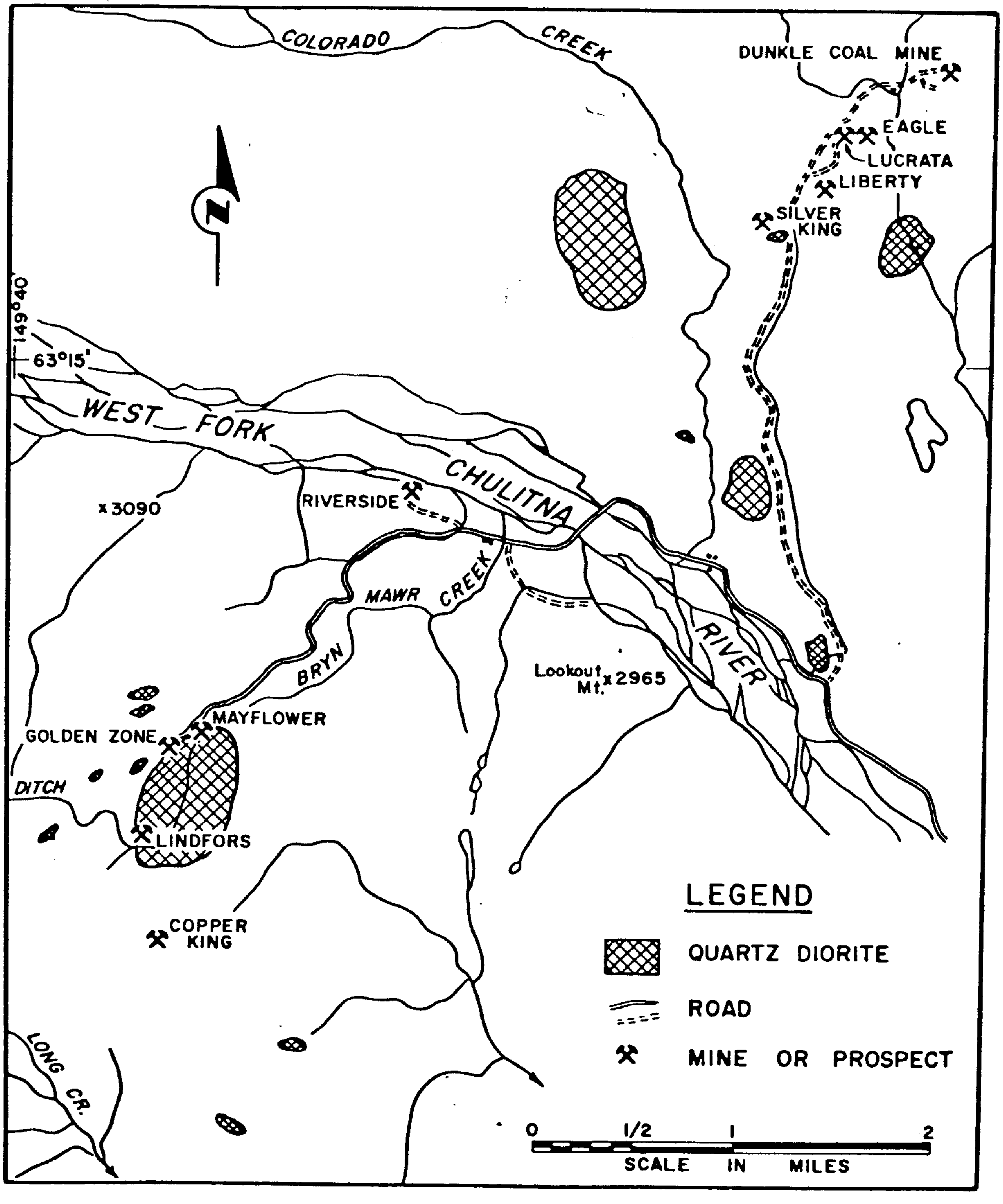


FIGURE 3. - Geologic Map, Golden Zone Mine and Other Nearby Prospects.

from the Golden Zone mine. During the winter, ski-equipped planes can land on a snow-covered bench within a half mile of the mine.

HISTORY AND PRODUCTION

The mineral deposits on the West Fork of the Chulitna River were brought to the attention of prospectors in 1907 when John Coffee, with Frank and Alonzo Wells, discovered and mined placer gold on Bryn Mawr Creek. Placer mining proved unprofitable but directed attention to the lode deposits which were actively prospected from 1911 to 1915. During this period, practically the entire belt of sulfide deposits was covered by lode claims. Except at the Golden Zone mine and adjacent prospects, there has been little exploration since that time.

The Golden Zone mine was discovered in 1912. The deposit had been exposed by a number of open cuts and 221 feet of underground workings when Stephen Capps (1)[3/] of the Geological Survey visited the area in 1917.

3/ Underlined numbers in parentheses refer to items in the bibliography at the end of this report.

Apparently little more had been accomplished when the Golden Zone claims and other nearby properties were acquired by W. E. Dunkle in 1935.

Representatives of Anaconda Copper Mining Co. examined the Golden Zone mine in 1937; the details of this examination are not known and the results are not available for publication.

A corporation to operate the mine, Golden Zone Mine, Inc., was formed by Mr. W. E. Dunkle, in 1939. Under corporate ownership, a hydroelectric powerplant, sawmill, flotation mill, mining plant, and camp facilities were constructed, and a large amount of underground exploration and development was accomplished.

The flotation mill on the property was operated intermittently during 1941 and part of 1942 to process ore from development openings, shrinkage stopes, and an open cut. This pilot plant type of operation, reportedly, indicated that the company's operating plans were feasible, but operational data are not available for inclusion in this report. Production records are in table 1.

TABLE 1. - Production record, Golden Zone mine[1]

Year	Tons	Concentrates produced[2] Gross metal content Gold, ounces	Silver, ounces	Copper, pounds	Lead, pounds
1941.....	789	1,464	8,070	40,648	2,976
1942.....	80	117	547	2,011	-
Totals...	869	1,581	8,617	42,659	2,976

1/ Reported to the Bureau of Mines by W. E. Dunkle.
2/ Shipments to Tacoma Smelter.

Company records indicate that the Golden Zone ores ranged in value downward from $10 or $12 per ton; the amount of this material that might be termed "ore" depended on its amenability to upgrading. Since a high percentage of the sulfide and associated minerals were known to occur in soft altered zones in and along fractures, the management planned to upgrade the ores by rough crushing followed by grinding and screening. It was thought that a high percentage of the more friable sulfide minerals could be separated as fines, while much of the relatively tougher gangue would remain in the oversize which could be discarded. The following outline of the proposed treatment plan was abstracted from reports and letters of W. E. Dunkle, president:

1. Crush mine-run ore to 1-1/2 inches.
2. Grind in ball mill with open discharge.
3. Screen to 1/2 inch; discard oversize. Possibly salvage some additional sulfides from the oversize by jigging or sink-float methods.
4. Undersize to jigs; discard jig tailings.
5. Jig products to bulk flotation; remove a copper-silver-gold concentrate.
6. Further flotation to remove an iron-arsenic concentrate.
7. Thicken and regrind the iron-arsenic concentrate.
8. Cyanidation of the iron-arsenic concentrate.

Operations were terminated late in 1942 due to wartime restrictions, failure to obtain additional capital, and other unforeseen circumstances. The mine has not been reopened, the facilities have deteriorated, and much of the equipment has been sold.

The Mayflower group of claims and the numerous other prospects in the area have not been developed beyond the raw prospect stage. Details of their history were not investigated.

Several Geological Survey field parties have studied the mineral deposits on the West Fork of the Chulitna River. S. R. Capps (1), (2), and (3) visited the area in 1917 and again in 1930. Clyde P. Ross (4) made a more detailed investigation of the deposits in 1931; his report includes data obtained by other members of the Geological Survey who made brief visits to the area during the 1920's, and the Bureau of Mines assay data. Richard Ray and John Reed, Jr. examined the Golden Zone mine in 1951 and, with W. S. Twenhofel and C. L. Sainsbury, logged the Bureau of Mines diamond-drill cores.

A Bureau of Mines engineer, R. L. Thorne, examined the Mayflower and Golden Zone claims in September 1949. A more detailed examination, made during the following summer by S. H. Lorain (then Regional Director for Alaska), was followed by the investigation described in this report. No exploration or development, other than annual assessment work by the owners, has been reported since that time.

PHYSICAL FEATURES, CLIMATE, AND WATER SUPPLY

The Golden Zone mine is on the south side of the valley of the West Fork of the Chulitna River about 2 miles from the river bank. The valley rises in a series of successively steeper terraces to the steep but smoothly rounded hills. Altitudes range from approximately 2,200 feet where the mine road leaves the river, to 3,275 feet at the Golden Zone camp, and to 5,500 feet at the summit of the hill immediately behind the camp. Bedrock often is exposed along the banks of creeks and rivers; elsewhere outcrops generally are covered by overburden ranging from a few feet deep on the steep hill slopes to unknown depths on the lower slopes and valley terraces. Surface prospecting is difficult because of the overburden and because of the permafrost which also penetrates to a considerable depth into bedrock.

Timberline in the region is at approximately 2,500 feet with some trees found to 3,000 feet elevation. Vegetation at the higher elevations is typically alpine, principally consisting of low brush, grass, and moss. The lower hill slopes and river valleys are covered with a dense growth of brush and trees. Spruce and cottonwood timber, some of which is suitable for mining and construction purposes, is available in the river valley.

The climate of the area, although generally typical of interior Alaska, is influenced by the nearby mountains of the Alaska Range. Consequently, drizzle and fog occur frequently during the summer, and the winters are characterized by low temperatures, high winds, and heavy snowfall. Snow usually lies on the ground from September to early June and often much later at the higher altitudes. Temperatures range from over 80° F in midsummer to -50° F in winter. During the colder winter months the temperatures in the timbered river valleys usually are 10 or more degrees colder than on the slopes above timberline. Weather data collected at Summit, about 18 miles northeast of the Golden Zone mine, is summarized in table 2.

TABLE 2. - Weather data, Summit, Alaska[1/]

Month	Average temperature, °F	Average precipitation, inches
January	2.6	1.01
February	7.5	1.33
March	11.2	1.32
April	23.3	.54
May	37.1	.98
June	48.9	2.13
July	52.4	3.38
August	48.7	3.37
September	40.4	3.35
October	25.6	1.89
November	9.6	1.43
December	3.2	1.52
Annual	25.8	22.25

Freezing temperature, last date in spring (1954)	May 29
Freezing temperature, first date in autumn (1954)	August 22
Ice breakup, Edes Lake (1954)	June 3
Ice freezeup, Edes Lake (1954)	October 8
Total annual snowfall (1954)	105.0 inches

1/ Data from publications of the U.S. Department of Commerce, Environmental Science Services Administration, Weather Bureau.

The Bureau field party, during the winter, obtained a constant flow of water for diamond drilling and camp use from a reservoir of mine-drainage water that had been impounded by caving ground on the 200 level of the Golden Zone mine.

Water for the flotation mill at the Golden Zone mine was taken from Bryn Mawr Creek. A ditch from the headwaters of Long Creek to the head of Bryn Mawr Creek augmented the flow. Data on the amount of water obtainable from this source is not available.

Water is obtainable throughout the year from gravel deposits in the bed of the West Fork of the Chulitna River. A Hydroelectric power plant, used during development, was operated with water from this source. Covered, timbered drains, installed on a clay "bedrock" about 10 feet below the gravel surface, formed a catchment that fed into a ditch which, in turn fed the power plant. During periods of minimum flow in late winter this installation is reported to have furnished enough water, clear and free of debris, to develop 150 horsepower under a head of 60 feet.

Fuel for heating, cooking, and other uses was obtained from the W. E. Dunkle coal mine on Costello Creek (5) and (6), about 8 miles by gravel road from the Golden Zone mine. Exploration of this mine during World War II revealed about 190,000 tons (including measured, indicated, and inferred reserves) of good grade subbituminous coal. The mine has been operated intermittently since that time, so the remaining reserves, if any, are not known.

PROPERTY AND OWNERSHIP

The principal workings of the Golden Zone mine were included in two claims: Golden Zone No. 2 and No. 3. Adjoining these claims on the north and generally following the trend of the mineralized belt were the Mayflower group which, in turn, were succeeded to the north by the Banner group and other claims. The titles were not checked and claims were not mapped. The claims in force in 1950 and 1951 are listed in table 3. Current ownership information may be obtained from the public records of the Alaska Department of Natural Resources, Division of Mines and Minerals, Juneau, Alaska.

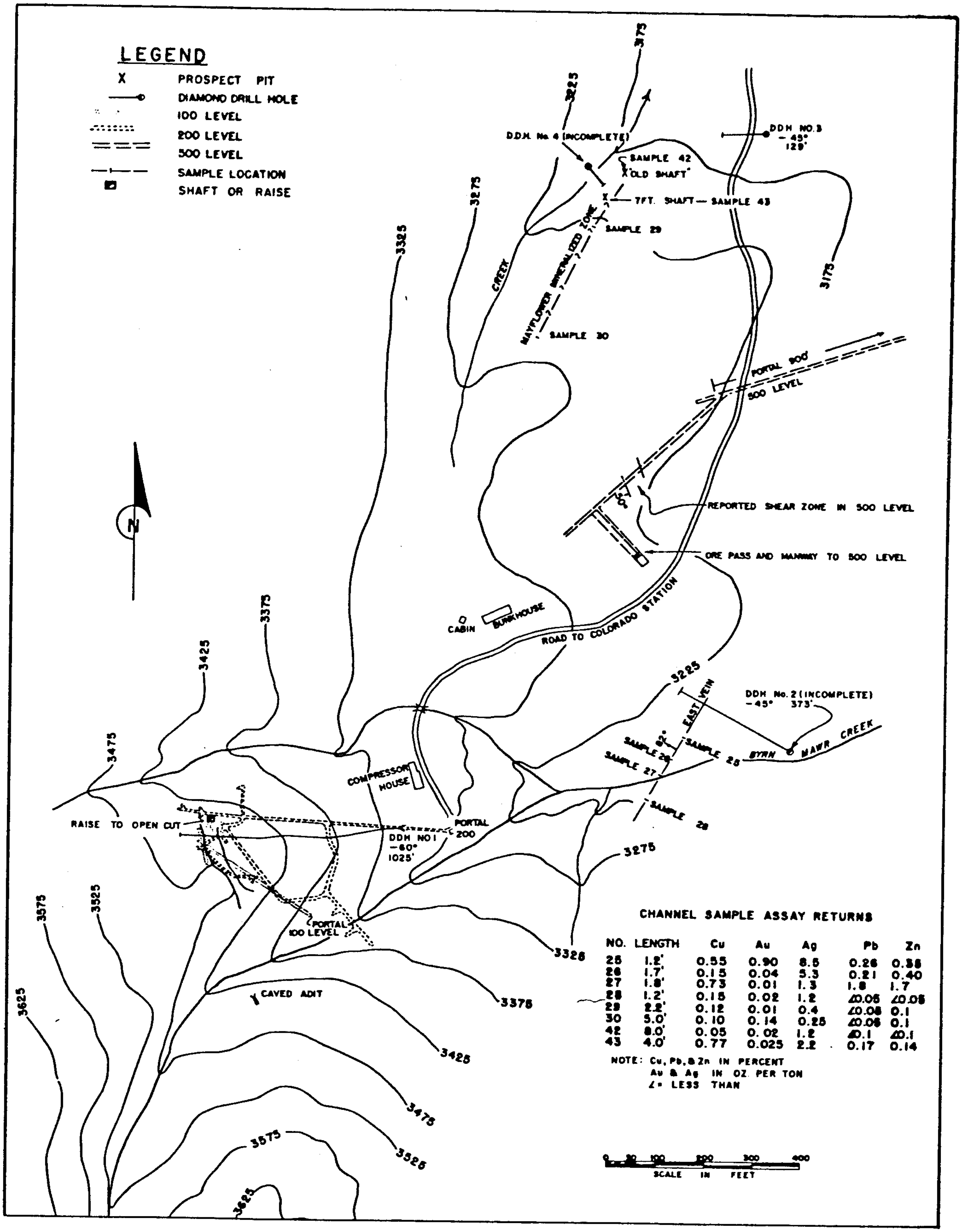
TABLE 3. - Unpatented lode claims, Golden Zone mine and adjacent prospects

Claim
Golden Zone No. 2 and No. 3.
Copper King No. 1 to No. 4, inclusive.
Sunset No. 1 and No. 2.
Riverside No. 1 to No. 13, inclusive.
West Fork.
Mayflower No. 1 and No. 2.
Banner No. 1 to No. 5, inclusive.

MINE WORKINGS

Exploration and development openings at the Golden Zone mine (fig. 4), include an opencut at an altitude of 3,452 feet and the 100, 200, and 500 adit levels driven at altitudes of 3,368, 3,278, and 2,962 feet, respectively. The 100 and 200 level adits intersect the deposit directly below the original opencut and are connected with intermediate stopes and the opencut by manways and ore passes. On the 200 level (figs 5-6), several long crosscuts and 18 diamond-drill holes explore lateral and vertical extensions of the deposit. The 500 level adit was planned to intersect the deposit approximately 300 feet below the 200 level to block out additional reserves and provide direct underground haulage to the flotation mill. This adit was advanced about 1,350 feet but was stopped about 900 feet short of the objective. The completed section was connected to the surface by a raise which, with intermediate truck haulage, was used to transport ore from the 200 level to the mill. The 500 level was inaccessible when examined in 1951. The 200 level adit was partly caved near the portal; water had accumulated back of the caves to a depth that made much of the level inaccessible but it could be entered from the 100 level. The ground stands well without timber support except in areas of faulting or intense alteration. A shrinkage stope on the 200 level from which most of the ore had been withdrawn before the close of operations in 1941, was standing open in 1951 with little evidence of caving or sloughing.

The Golden Zone mine is the only extensively developed prospect in the area. Workings at the other prospects are shallow tunnels, shafts, pits, and trenches, practically all of which were completed prior to 1917, and



CHANNEL SAMPLE ASSAY RETURNS

NO.	LENGTH	Cu	Au	Ag	Pb	Zn
25	1.2'	0.55	0.90	8.5	0.26	0.35
26	1.7'	0.15	0.04	5.3	0.21	0.40
27	1.8'	0.73	0.01	1.3	1.8	1.7
28	1.2'	0.15	0.02	1.2	∠0.05	∠0.05
29	2.2'	0.12	0.01	0.4	∠0.05	0.1
30	5.0'	0.10	0.14	0.25	∠0.05	0.1
42	8.0'	0.05	0.02	1.2	∠0.1	∠0.1
43	4.0'	0.77	0.025	2.2	0.17	0.14

NOTE: Cu, Pb, & Zn IN PERCENT
Au & Ag IN OZ. PER TON
∠= LESS THAN

FIGURE 4. - Plan Map, Golden Zone Mine Workings, Bureau of Mines Surface Samples and Drillholes.

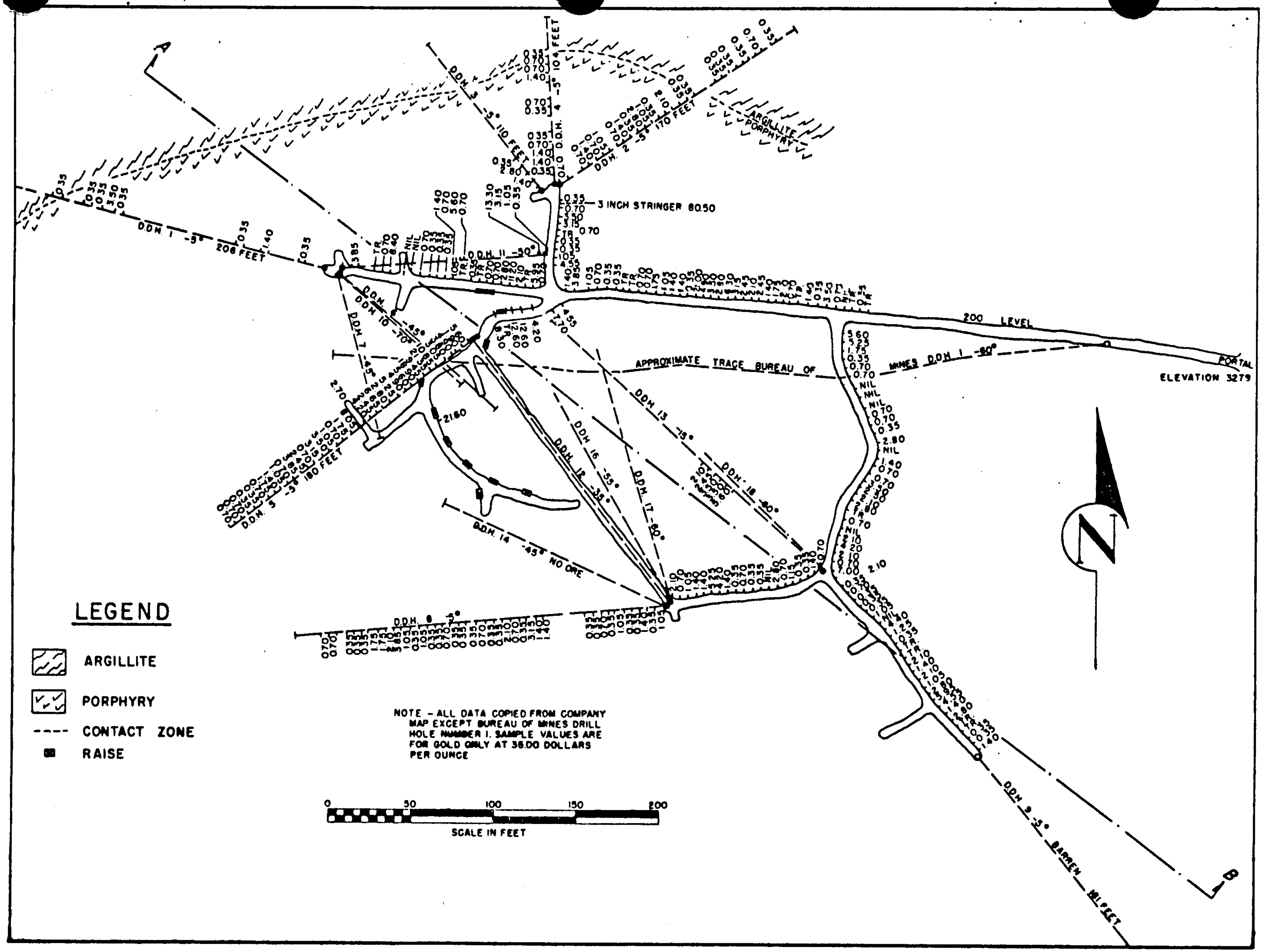


FIGURE 5. - Assay Map of 200 Level and Diamond-Drill Holes, Golden Zone Mine, Inc.

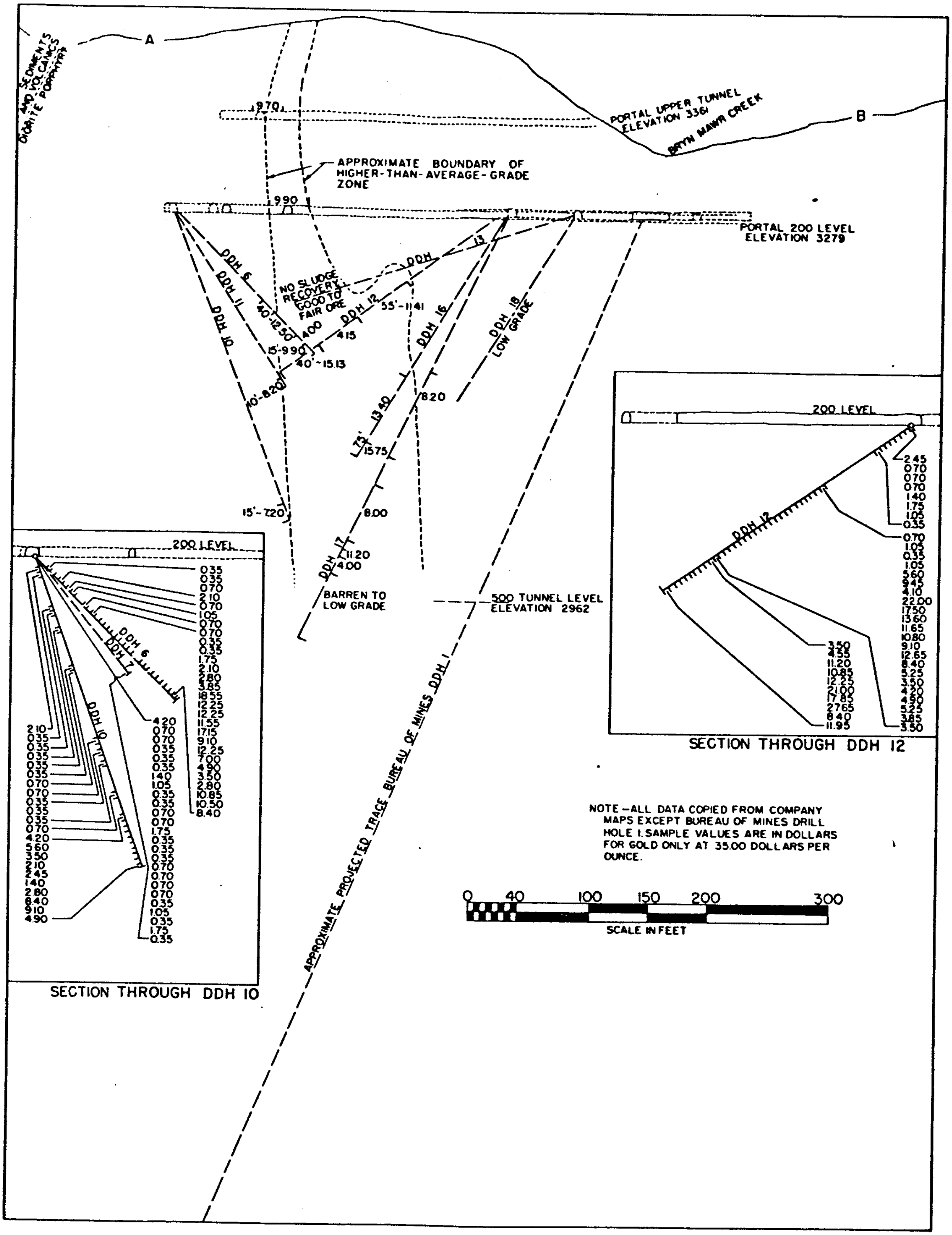


FIGURE 6. - Section A-B, Golden Zone Mine, Inc.

most of which are now caved. Adjacent to the Golden Zone outcrop, a series of shallow trenches in the valley of Bryn Mawr Creek explored the East Vein for a strike length of about 300 feet. The adjoining Mayflower claims were explored by several trenches and two shallow shafts; the "Old Shaft" reportedly was 30 feet deep, but has caved to within 10 feet of the surface; the other shaft apparently was shallower.

GENERAL GEOLOGY

The Golden Zone mine is located on a group of generally similar sulfide deposits forming a belt over 6 miles long roughly aligned in a northeast-southwest direction (fig. 3). Starting from the northeast end, the principal prospects in this group are the Eagle, Lucrata, Liberty, Silver King, Riverside, Mayflower, Golden Zone, Lindfors, and Copper King. Genetically, these lodes are related to a number of small stocks and dikes, principally of diorite or diorite porphyry, which have intruded a complexly interlayered group of metamorphosed sedimentary and volcanic rocks. Hydrothermal solutions invaded both the intrusives and the surrounding sedimentary and volcanic rocks to form widespread but individually discontinuous sulfide deposits aligned along fractures, contacts, bedding planes, and other openings. Zones of intense fracturing contain numerous closely spaced deposits of this type. Locally, the relative proportions of the principal metallic minerals vary widely, but the usual order of abundance is: Arsenopyrite, pyrite, pyrrhotite, chalcopyrite, sphalerite, and galena. Gold and silver occur associated with the sulfides. The widespread occurrence of both the intrusive rocks and the associated metallic minerals would suggest that generally similar metallization may persist to considerable depths. Weathering rarely extends more than 5 or 10 feet below the surface; there is no evidence of significant zones of secondary enrichment.

DESCRIPTION OF THE DEPOSITS

Golden Zone

The Golden Zone mine (fig. 4) and nearby prospects are in or directly adjacent to a small quartz-diorite porphyry stock that has intruded calcareous argillite, tuff, and shale. Almost the entire stock contains disseminated iron-bearing sulfide minerals that weather to a conspicuous red color on the outcrop (early prospectors named the outcrop "Rusty Hill"). The intrusive has been strongly fractured, and in some places, closely sheeted; bleaching and alteration of the original minerals is widespread but more prominent near fractures. Arsenopyrite and pyrite, with some chalcopyrite and less galena and sphalerite are the principal sulfides. Gold and silver are associated with the sulfides, but there is considerable variation in the relative amounts of gold and sulfides present in any given sample. Metallic minerals are most abundant in the more intensely broken or sheeted zones, but the extent and distribution of fracture zones remains unknown.

The Golden Zone mine workings (figs. 5-6) explore a roughly semicircular zone of intense fracturing and alteration within the body of the stock. The boundaries are irregular and indefinite, but the zone has been proven from the opencut on "Rusty Hill" to the 200 level; continuation for at least several hundred feet below the 200 level is indicated by diamond-drill holes. The amount of metallic minerals present appears to be in direct proportion to the amount of fracturing; sulfide minerals tend to concentrate in and along the fractures and to be less abundant in the intervening rock.

East Vein

The East Vein (fig. 4) is a northeasterly trending sulfide zone which crops out in the canyon of Bryn Mawr Creek a short distance east of the 200 level portal. Open cuts have exposed this zone at intervals for a length of about 300 feet. It ranges from 1 to 8 feet in width with indefinite walls. Minerals are similar to those in the Golden Zone mine but erratic in distribution; arsenopyrite predominates but some channel samples and picked specimens show concentrations of sphalerite and galena. A vein, thought to be a faulted segment of the East Vein, was intersected near the face of the 500 level adit; selected specimens reportedly contained considerable silver and lead. The 500 level was inaccessible at the time of the investigation and the only specimen obtainable (specimen 4, table 4) contained principally arsenopyrite.

Mayflower Deposit

The Mayflower deposit (fig. 4) is infrequently exposed on a ridge and in several shallow cuts northeast of the Golden Zone mine. Pyrite and arsenopyrite are the predominant minerals although some specimens display equal or greater amounts of chalcopyrite and sphalerite; some gold and silver is present. Mineral distribution is erratic and discontinuous. The deposit can be traced with fair accuracy for a strike length of approximately 350 feet; apparently it strikes about N 25° to 35° E and dips vertically or steeply southeast.

The wall rock exposed near the "Old Shaft" is a brecciated, iron-stained, highly altered, extremely fine-grained argillite. The Mayflower deposit appears to be related to the Golden Zone deposit but the exact relationship has not been determined.

BUREAU OF MINES WORK

Purpose and Scope

The Bureau of Mines investigated the Golden Zone mine and nearby deposits to determine the amount of recoverable copper, lead, zinc, or other valuable metals associated with gold. Mine workings and diamond-drill holes, completed by the operating company, had indicated moderate reserves of low-grade gold ore; additional and larger reserves of similar grade could be inferred from the geology of the Golden Zone and associated deposits. Copper, lead, and zinc had been recovered as a byproduct of the gold recovery process but the amount of these metals in the ore had not been determined.

The Bureau of Mines program, therefore, contemplated a study of the company sampling data and check sampling of representative exposures of the Golden Zone deposit, the East Vein, and the Mayflower lode. This was to have been followed by diamond-drill sampling to delimit the ore bodies and possible extensions. If the sampling and drilling program indicated the presence of important base metal reserves, metallurgical tests to determine methods of recovery were to follow.

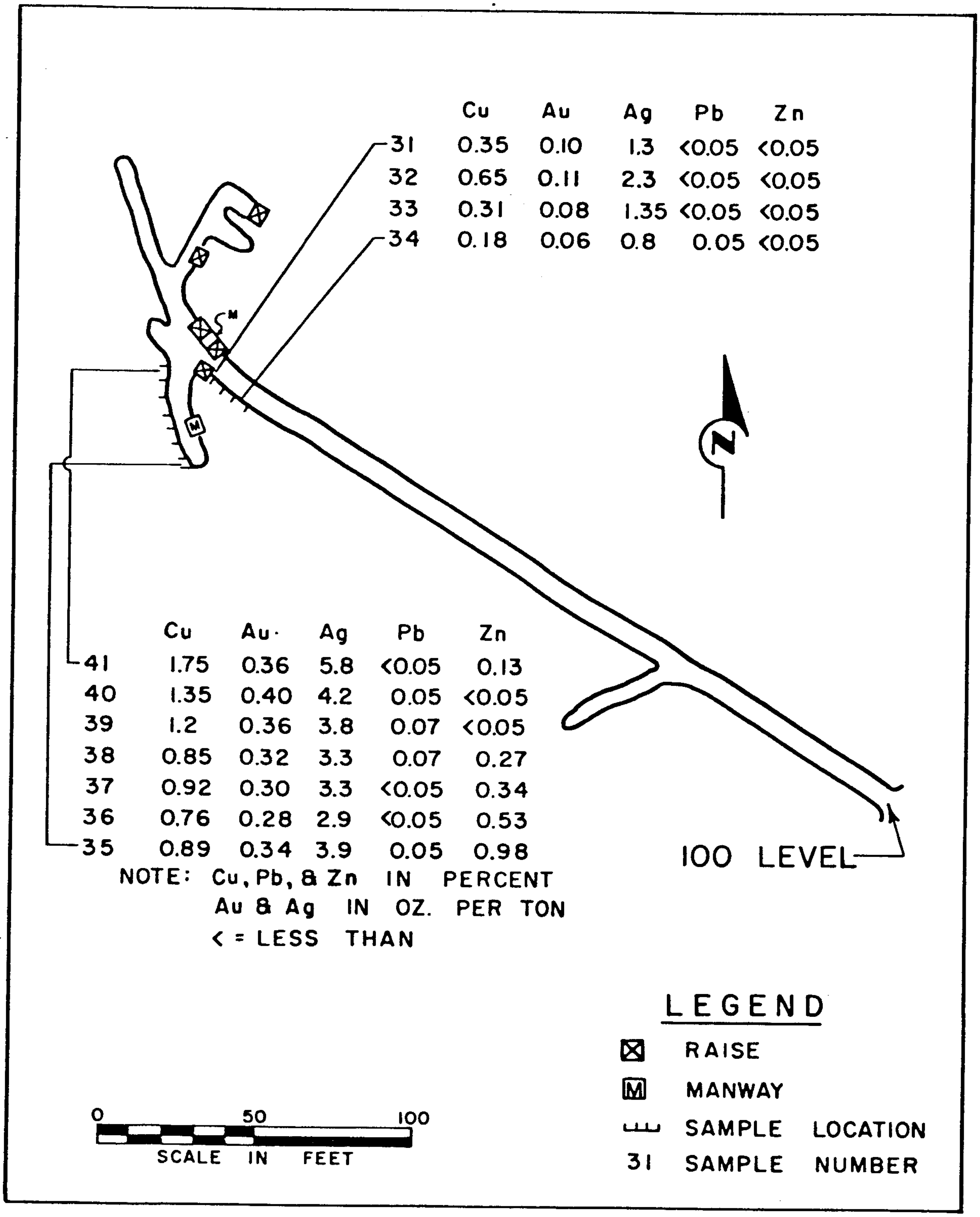
The results of the Bureau's check sampling roughly agreed with the company data; however, the nature of the rock made core drilling impractical. No other means of delimiting the deposits were available at the time, so the Bureau's sampling program had to be abandoned without achieving conclusive results. Consequently, metallurgical work was limited to tests to determine the general nature of the beneficiation problems.

Check Sampling and Trenching

Golden Zone

Channel samples were cut from representative sections of the Golden Zone ore body exposed on the 100 and 200 levels along the sides of drifts and crosscuts. Walls were first cleaned of oxidized material. Channels were then cut waist high, in 5-foot lengths, to uniform width and depth; cuttings averaged 7 to 8 pounds per foot of channel or 35 to 40 pounds per 5-foot sample. These samples were forwarded intact to the Juneau laboratory where they were successively cut and crushed to obtain representative splits for chemical analyses. Rejects of samples from both drifts and crosscuts were composited for metallurgical tests. Sample locations and analyses are on figures 7 and 8.

Selected specimens from the Golden Zone ore body and nearby outcrops were submitted for petrographic analyses; sample descriptions and results are in table 4.

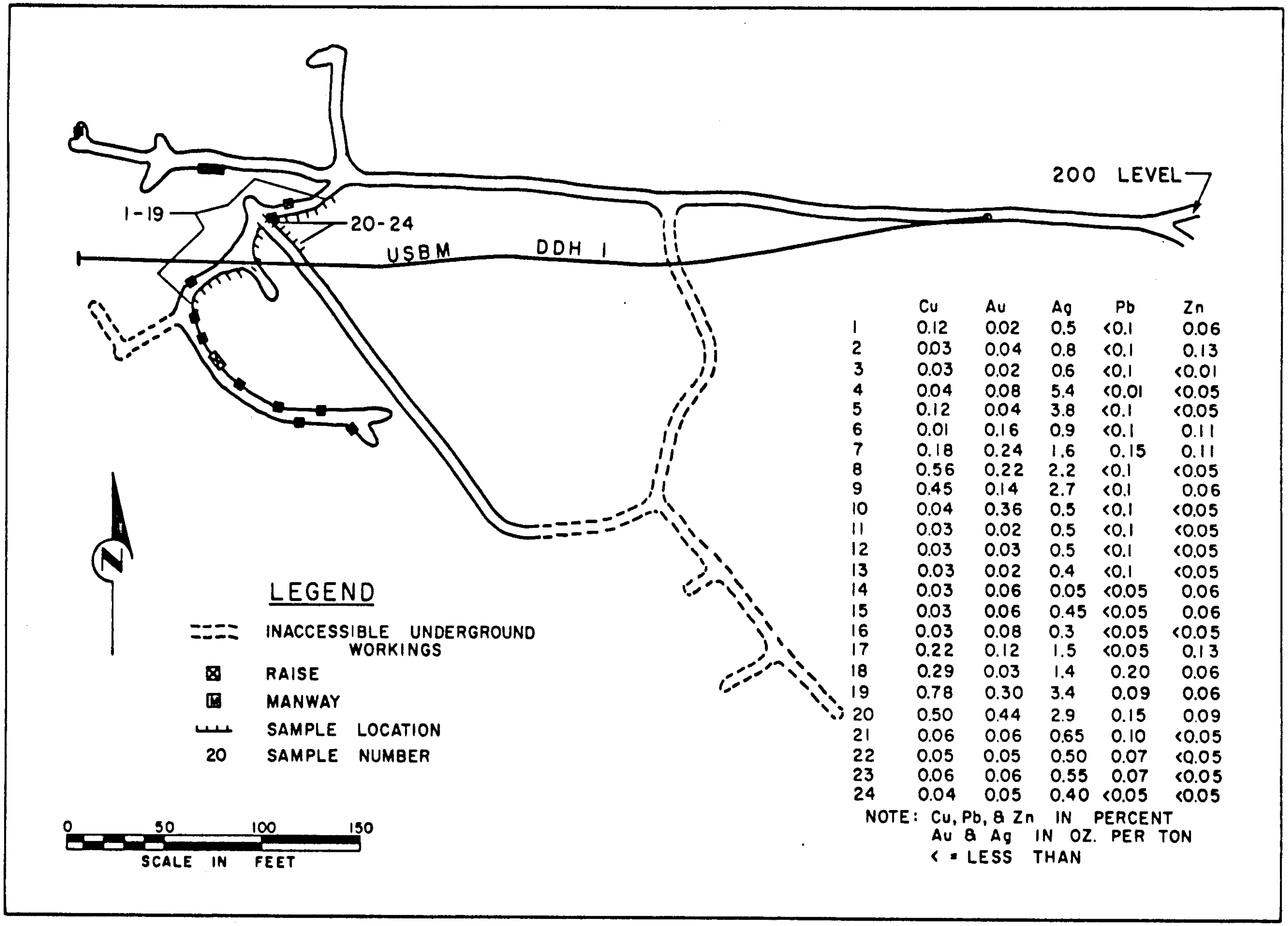


	Cu	Au	Ag	Pb	Zn
31	0.35	0.10	1.3	<0.05	<0.05
32	0.65	0.11	2.3	<0.05	<0.05
33	0.31	0.08	1.35	<0.05	<0.05
34	0.18	0.06	0.8	0.05	<0.05

	Cu	Au	Ag	Pb	Zn
41	1.75	0.36	5.8	<0.05	0.13
40	1.35	0.40	4.2	0.05	<0.05
39	1.2	0.36	3.8	0.07	<0.05
38	0.85	0.32	3.3	0.07	0.27
37	0.92	0.30	3.3	<0.05	0.34
36	0.76	0.28	2.9	<0.05	0.53
35	0.89	0.34	3.9	0.05	0.98

NOTE: Cu, Pb, & Zn IN PERCENT
Au & Ag IN OZ. PER TON
< = LESS THAN

FIGURE 7. - Bureau of Mines Channel Samples, 100 Level, Golden Zone Mine.



	Cu	Au	Ag	Pb	Zn
1	0.12	0.02	0.5	<0.1	0.06
2	0.03	0.04	0.8	<0.1	0.13
3	0.03	0.02	0.6	<0.1	<0.01
4	0.04	0.08	5.4	<0.01	<0.05
5	0.12	0.04	3.8	<0.1	<0.05
6	0.01	0.16	0.9	<0.1	0.11
7	0.18	0.24	1.6	0.15	0.11
8	0.56	0.22	2.2	<0.1	<0.05
9	0.45	0.14	2.7	<0.1	0.06
10	0.04	0.36	0.5	<0.1	<0.05
11	0.03	0.02	0.5	<0.1	<0.05
12	0.03	0.03	0.5	<0.1	<0.05
13	0.03	0.02	0.4	<0.1	<0.05
14	0.03	0.06	0.05	<0.05	0.06
15	0.03	0.06	0.45	<0.05	0.06
16	0.03	0.08	0.3	<0.05	<0.05
17	0.22	0.12	1.5	<0.05	0.13
18	0.29	0.03	1.4	0.20	0.06
19	0.78	0.30	3.4	0.09	0.06
20	0.50	0.44	2.9	0.15	0.09
21	0.06	0.06	0.65	0.10	<0.05
22	0.05	0.05	0.50	0.07	<0.05
23	0.06	0.06	0.55	0.07	<0.05
24	0.04	0.05	0.40	<0.05	<0.05

NOTE: Cu, Pb, & Zn IN PERCENT
Au & Ag IN OZ. PER TON
< = LESS THAN

FIGURE 8. - Bureau of Mines Channel Samples, 200 Level, Golden Zone Mine.

East Vein

Four hand-dug trenches were excavated along the steep slope of the valley of Bryn Mawr Creek to expose the outcrop of the East Vein. Channel samples Nos. 25-28, inclusive, were cut across widths ranging from 1.2 to 1.8 feet. Sample locations and analyses are on figure 4.

Mayflower Deposit

Cross sections of the Mayflower deposit were exposed by removing overburden with a bulldozer. Samples Nos. 29 and 30 were taken from the bottom of the bulldozer cuts. Sample No. 42 was cut across a mineralized zone exposed 8 feet below the surface in the "Old Shaft." Sample No. 43 was obtained from a 4-foot width of the Mayflower vein exposed at the bottom of a 7-foot shaft. Sample locations and analyses are on figure 4.

TABLE 4. - Petrographic analyses of selected specimens from mine openings and trenches

No.	Specimen: Location and field description	Analyses
1	Opencut; highly altered soft green north-south "dike" in opencut above Golden Zone stope.	This sample is composed chiefly of epidote and arsenopyrite associated with a minor amount of quartz and sericite mica. As epidote is most commonly of metamorphic origin and there is no evidence of what the primary rock was, it is necessary to speculate and assume the epidote was first formed by contact metamorphism of either a calcareous sediment or of a calcitic igneous rock. Subsequently, the arsenopyrite invaded the epidote and filled in the honeycombed structure. There appears to have been little replacement of the epidote by arsenopyrite which evidently is of later origin.
2	100 level; ore from high-grade area near stope on 100 level.	This specimen is an acidic igneous rock, composed chiefly of quartz, feldspar, and probably ferromagnesian minerals, that has been altered and partly replaced by arsenopyrite, sphalerite, chalcopyrite, and pyrite along a well-defined fracture or vein. Some arsenopyrite, the chief sulfide mineral present, also occurs disseminated throughout the mass of the igneous rock. Virtually all of the chalcopyrite occurs as minute inclusions in sphalerite. In addition to the sulfide minerals, considerable sericite mica and dolomite have been formed by the mineralizing solutions through alteration and replacement of the primary minerals of the original igneous rock.
3	200 level; mafic rock from the 200 level, Golden Zone.	This sample is composed chiefly of coarsely crystalline hornblende associated with lesser amounts of epidote and quartz. A small amount of chalcopyrite occurs disseminated throughout the rock but not associated with any other mineral. The original rock is little altered; some epidote was formed by the metamorphism and chalcopyrite was subsequently introduced.
4	500 level; ore, possibly a segment of the East Vein (taken by Dunkle).	The sample is composed of massive arsenopyrite associated with quartz, both minerals being subsequently cut by small veinlets filled with dolomite. No original rock was noted in this sample.

TABLE 4. - Petrographic analyses of selected specimens from mine openings and trenches--continued

Specimen No.	Location and field description	Analyses
5	East Vein; typical specimen.	This sample contains sulfides of pyrite, arsenopyrite, sphalerite, chalcopyrite, and galena. The associated gangue minerals are quartz, dolomite, and chalcedony. Pyrite and arsenopyrite are the main sulfides and are found throughout this quartzitic rock. The other sulfides appear to be of different periods of mineralization and are associated with and replace the dolomite.
6	Mayflower deposit; dense black rock exposed on top of the small hill near the "Old Shaft."	This sample is a highly altered igneous rock composed chiefly of actinolite and feldspars associated with minor amounts of calcite, quartz, sphene, and pyrite. The alteration of the original igneous rock may be due to its close contact with a younger intrusive.

Diamond-Core Drilling

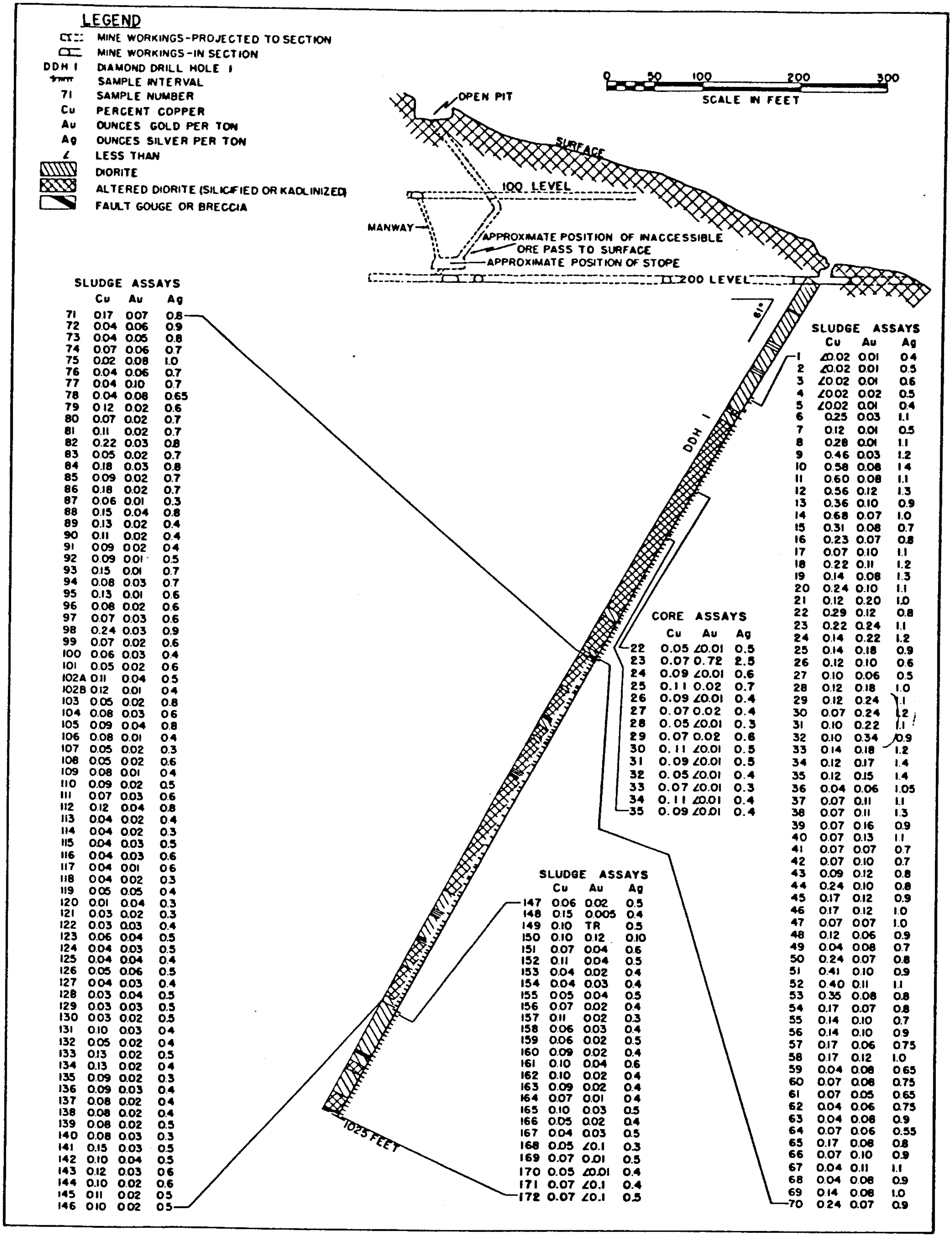
The drilling phase of the project, as originally planned, included deep-hole intersections of the Golden Zone deposit and a number of shorter holes to test the East Vein and Mayflower deposits. However, numerous hard bands of broken silicified material in a comparatively soft formation made drilling slow and difficult and bit wear excessive. The many mud seams and open fractures necessitated frequent cementing (or reaming and casing) to prevent caving and excessive sludge yield, or to maintain sludge return. Indicative of the difficulties encountered is the fact that, although skilled and experienced drillers were employed, hole 1 was started in January and was not completed until the following August. The adverse drilling conditions and resultant doubtful samples and high costs made it necessary to terminate the work after completing only one long and one short hole. Two additional holes were abandoned before reaching the planned depths.

Interpretation of the drilling results is questionable. Core recovery from all holes was poor and the sample value of the recovered core sections is dubious. The sulfide minerals are most abundant in the fractured parts of the deposit which also are the most difficult to core. The sulfides are very friable; a high percentage was ground into sludge. Sludge sample evaluation is uncertain because of the erratic sludge recovery resulting from the many fractures and soft seams which also may have either enriched or robbed the samples. Table 10 lists the percentages of core and sludge recovered.

Cores and sludges were forwarded intact to the Juneau field station for logging and analyses. Sludges were collected in a series of three

10- by 1- by 1-foot boxes equipped with under- and over-baffles. Lime water was used to promote settling when necessary. Sludge samples from the mineralized sections of holes were analyzed for gold, silver, and copper; core samples from the more strongly mineralized sections of the holes, as indicated by sludge assays, were analyzed for comparative purposes. All cores were scanned by ultraviolet light and geiger counter; no fluorescent or radioactive minerals were detected. Representative core specimens were submitted to petrographic and spectrographic analyses.

Hole locations are on figure 4; chemical analyses and geological sections are in figures 9 through 11. Drillhole logs, petrographic and spectrographic analyses, and core and sludge analyses are in tables 4 through 10.



SLUDGE ASSAYS

	Cu	Au	Ag
71	0.17	0.07	0.8
72	0.04	0.06	0.9
73	0.04	0.05	0.8
74	0.07	0.06	0.7
75	0.02	0.08	1.0
76	0.04	0.06	0.7
77	0.04	0.10	0.7
78	0.04	0.08	0.65
79	0.12	0.02	0.6
80	0.07	0.02	0.7
81	0.11	0.02	0.7
82	0.22	0.03	0.8
83	0.05	0.02	0.7
84	0.18	0.03	0.8
85	0.09	0.02	0.7
86	0.18	0.02	0.7
87	0.06	0.01	0.3
88	0.15	0.04	0.8
89	0.13	0.02	0.4
90	0.11	0.02	0.4
91	0.09	0.02	0.4
92	0.09	0.01	0.5
93	0.15	0.01	0.7
94	0.08	0.03	0.7
95	0.13	0.01	0.6
96	0.08	0.02	0.6
97	0.07	0.03	0.6
98	0.24	0.03	0.9
99	0.07	0.02	0.6
100	0.06	0.03	0.4
101	0.05	0.02	0.6
102A	0.11	0.04	0.5
102B	0.12	0.01	0.4
103	0.05	0.02	0.8
104	0.08	0.03	0.6
105	0.09	0.04	0.8
106	0.08	0.01	0.4
107	0.05	0.02	0.3
108	0.05	0.02	0.6
109	0.08	0.01	0.4
110	0.09	0.02	0.5
111	0.07	0.03	0.6
112	0.12	0.04	0.8
113	0.04	0.02	0.4
114	0.04	0.02	0.3
115	0.04	0.03	0.5
116	0.04	0.03	0.6
117	0.04	0.01	0.6
118	0.04	0.02	0.3
119	0.05	0.05	0.4
120	0.01	0.04	0.3
121	0.03	0.02	0.3
122	0.03	0.03	0.4
123	0.06	0.04	0.5
124	0.04	0.03	0.5
125	0.04	0.04	0.4
126	0.05	0.06	0.5
127	0.04	0.03	0.4
128	0.03	0.04	0.5
129	0.03	0.03	0.5
130	0.03	0.02	0.5
131	0.10	0.03	0.4
132	0.05	0.02	0.4
133	0.13	0.02	0.5
134	0.13	0.02	0.4
135	0.09	0.02	0.3
136	0.09	0.03	0.4
137	0.08	0.02	0.4
138	0.08	0.02	0.4
139	0.08	0.02	0.5
140	0.08	0.03	0.3
141	0.15	0.03	0.5
142	0.10	0.04	0.5
143	0.12	0.03	0.6
144	0.10	0.02	0.6
145	0.11	0.02	0.5
146	0.10	0.02	0.5

SLUDGE ASSAYS

	Cu	Au	Ag
1	<0.02	0.01	0.4
2	<0.02	0.01	0.5
3	<0.02	0.01	0.6
4	<0.02	0.02	0.5
5	<0.02	0.01	0.4
6	0.25	0.03	1.1
7	0.12	0.01	0.5
8	0.28	0.01	1.1
9	0.46	0.03	1.2
10	0.58	0.08	1.4
11	0.60	0.08	1.1
12	0.56	0.12	1.3
13	0.36	0.10	0.9
14	0.68	0.07	1.0
15	0.31	0.08	0.7
16	0.23	0.07	0.8
17	0.07	0.10	1.1
18	0.22	0.11	1.2
19	0.14	0.08	1.3
20	0.24	0.10	1.1
21	0.12	0.20	1.0
22	0.29	0.12	0.8
23	0.22	0.24	1.1
24	0.14	0.22	1.2
25	0.14	0.18	0.9
26	0.12	0.10	0.6
27	0.10	0.06	0.5
28	0.12	0.18	1.0
29	0.12	0.24	1.1
30	0.07	0.24	1.2
31	0.10	0.22	1.1
32	0.10	0.34	0.9
33	0.14	0.18	1.2
34	0.12	0.17	1.4
35	0.12	0.15	1.4
36	0.04	0.06	1.05
37	0.07	0.11	1.1
38	0.07	0.11	1.3
39	0.07	0.16	0.9
40	0.07	0.13	1.1
41	0.07	0.07	0.7
42	0.07	0.10	0.7
43	0.09	0.12	0.8
44	0.24	0.10	0.8
45	0.17	0.12	0.9
46	0.17	0.12	1.0
47	0.07	0.07	1.0
48	0.12	0.06	0.9
49	0.04	0.08	0.7
50	0.24	0.07	0.8
51	0.41	0.10	0.9
52	0.40	0.11	1.1
53	0.35	0.08	0.8
54	0.17	0.07	0.8
55	0.14	0.10	0.7
56	0.14	0.10	0.9
57	0.17	0.06	0.75
58	0.17	0.12	1.0
59	0.04	0.08	0.65
60	0.07	0.08	0.75
61	0.07	0.05	0.65
62	0.04	0.06	0.75
63	0.04	0.08	0.9
64	0.07	0.06	0.55
65	0.17	0.08	0.8
66	0.07	0.10	0.9
67	0.04	0.11	1.1
68	0.04	0.08	0.9
69	0.14	0.08	1.0
70	0.24	0.07	0.9

CORE ASSAYS

	Cu	Au	Ag
22	0.05	<0.01	0.5
23	0.07	0.72	2.5
24	0.09	<0.01	0.6
25	0.11	0.02	0.7
26	0.09	<0.01	0.4
27	0.07	0.02	0.4
28	0.05	<0.01	0.3
29	0.07	0.02	0.6
30	0.11	<0.01	0.5
31	0.09	<0.01	0.5
32	0.05	<0.01	0.4
33	0.07	<0.01	0.3
34	0.11	<0.01	0.4
35	0.09	<0.01	0.4

SLUDGE ASSAYS

	Cu	Au	Ag
147	0.06	0.02	0.5
148	0.15	0.005	0.4
149	0.10	TR	0.5
150	0.10	0.12	0.10
151	0.07	0.04	0.6
152	0.11	0.04	0.5
153	0.04	0.02	0.4
154	0.04	0.03	0.4
155	0.05	0.04	0.5
156	0.07	0.02	0.4
157	0.11	0.02	0.3
158	0.06	0.03	0.4
159	0.06	0.02	0.5
160	0.09	0.02	0.4
161	0.10	0.04	0.6
162	0.10	0.02	0.4
163	0.09	0.02	0.4
164	0.07	0.01	0.4
165	0.10	0.03	0.5
166	0.05	0.02	0.4
167	0.04	0.03	0.5
168	0.05	<0.1	0.3
169	0.07	0.01	0.5
170	0.05	<0.01	0.4
171	0.07	<0.1	0.4
172	0.07	<0.1	0.5

FIGURE 9. - Geologic Section, Bureau of Mines Drillhole 1, Golden Zone Mine.

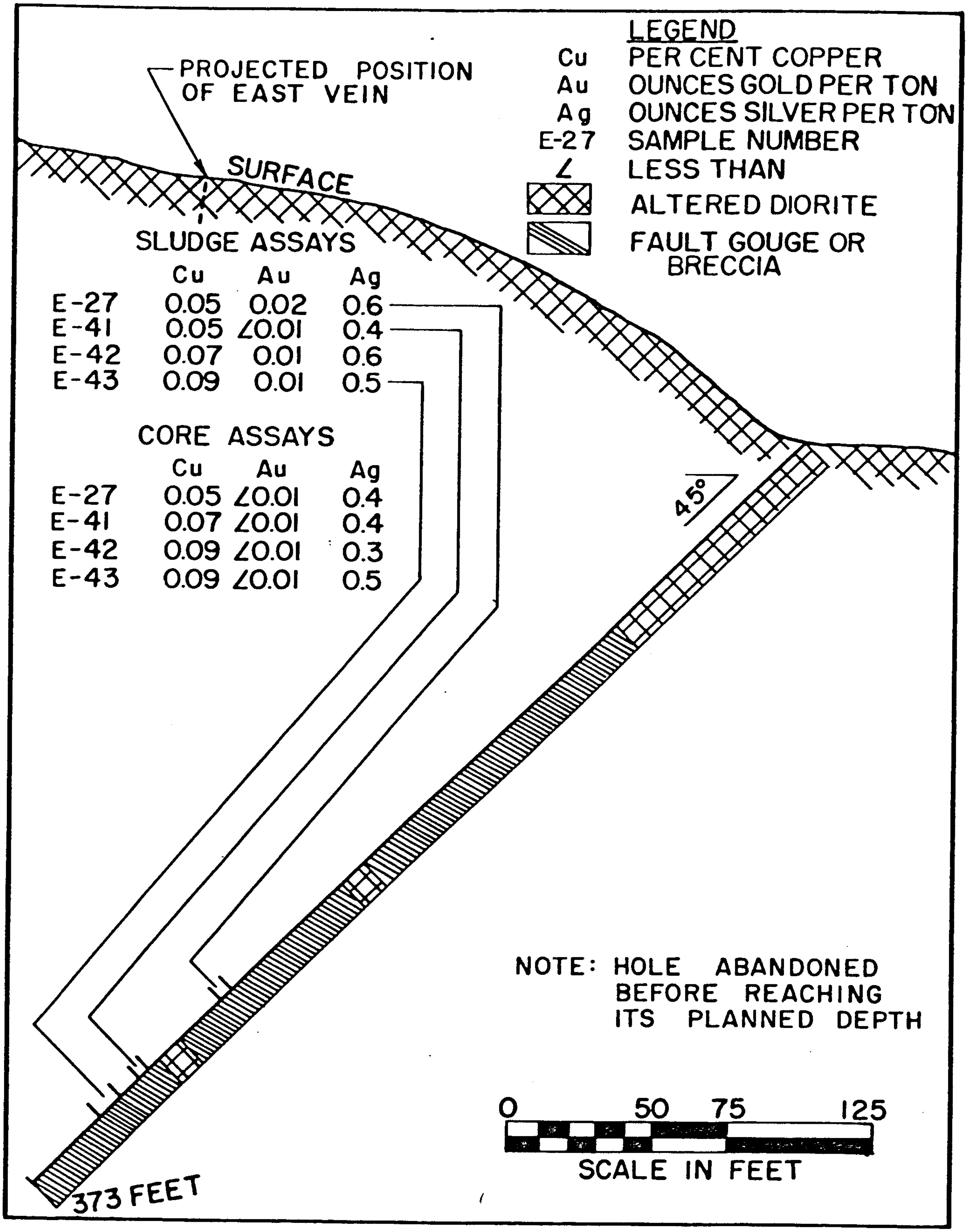


FIGURE 10. - Geologic Section, Bureau of Mines Drillhole 2, Golden Zone Mine.

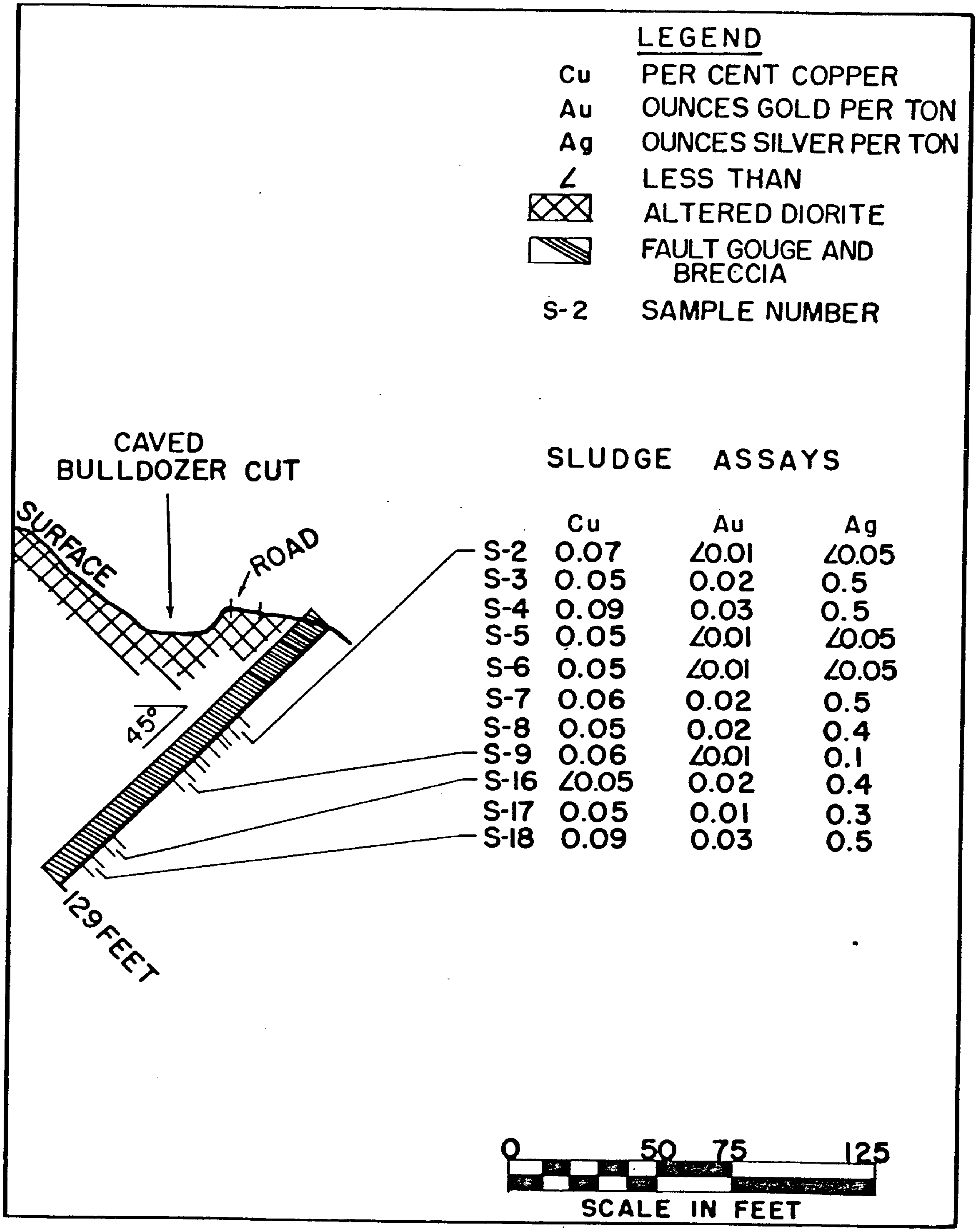


FIGURE 11. - Geologic Section, Bureau of Mines Drillhole 3, Mayflower Claims.

Diamond-drill Hole 1

Bureau drillhole No. 1 was collared from an underground station 73 feet from the portal of the 200 level adit. A surface station was possible, but the underground location was selected because of the desirability of continuing the work during the winter. Hole No. 1 was drilled on a line bearing S 84°45' W and dipping -61°; it was pointed to intersect the Golden Zone ore deposit approximately 400 feet below the lowest previous drillhole penetration and was completed to a depth of 1,025 feet. Bearings and dips below the collar were obtained by means of a drillhole surveying instrument.

Diamond-drill Holes 2, 3, and 4

Hole No. 2 was collared in the bed of Bryn Mawr Creek. The hole was drilled on a line bearing N 60° W and dipping -45° to intersect the projection of the East Vein at a point approximately 400 feet below the outcrop. The hole was drilled to 373 feet, but had to be abandoned because of difficult drilling conditions and a breakdown of the drill engine.

Holes Nos. 3 and 4 are on the Mayflower claims. Hole No. 3 was drilled on a line bearing N 88° W and dipping -45° to intersect a reported zone of closely spaced veinlets containing lead and zinc minerals. The hole was bottomed at 129 feet; this was the only short hole completed to its planned depth. Hole No. 4 was intended to explore the Mayflower zone in the vicinity of the "Old Shaft" but had to be abandoned at a depth of only 35 feet when cold weather caused failure of the water supply.

TABLE 5. - Log of Bureau of Mines diamond-drill hole 1[1/]

Depth, feet from	to	Formations
0.0	38.0	Diorite, hard, dense, fine-grained, feldspar altered to a milky greenish color. A small amount of biotite present.
38.0	40.0	Fault gouge, fine-grained, clay-like.
40.0	78.0	Diorite, same as 0-38 feet.
78.0	80.8	Fault gouge, same as 38-40 feet.
80.8	82.0	Silicified diorite.
82.0	83.6	Fault gouge, same as 38-40 feet.
83.6	111.0	Diorite, same as 0-38 feet.
111.0	114.8	Fault gouge, same as 38-40 feet.
114.8	159.5	Diorite, same as 0-38 feet.
159.5	165.5	Silicified diorite, with about 1 percent disseminated pyrite. This rock represents the diorite (same as 0-38 feet above) that has been thoroughly impregnated and replaced by quartz.
165.5	175.5	Diorite, same as 0-38 feet.
175.5	216.5	Silicified diorite, with pyrite, chalcopyrite, and several arsenopyrite disseminated in zones separated by several inches of rock with no sulfides. Total sulfides in this core comprise 1-2 percent of the rock.
216.5	228.0	Silicified diorite, with about 7 percent pyrite, 7 percent arsenopyrite, and 1 percent chalcopyrite. Arsenopyrite occurs as distinct, well-formed separate crystals; pyrite and chalcopyrite occur as formless masses.
228.0	291.0	Silicified diorite, with 2-3 percent arsenopyrite and a trace of pyrite and chalcopyrite.
291.0	408.0	Silicified diorite, with a trace of pyrite, chalcopyrite, and arsenopyrite.
408.0	418.3	Diorite, same as 0-38 feet.
418.3	455.0	Silicified diorite, with only a trace of sulfides.
455.0	460.0	Diorite, white to light gray with altered feldspar phenocrysts 1-5 mm long; 3 percent chalcopyrite, 1 percent arsenopyrite, 1 percent pyrite.
460.0	464.2	Silicified diorite, with disseminated arsenopyrite (1-2 percent).
464.2	466.0	Silicified diorite with a trace of disseminated chalcopyrite.
466.0	468.3	Silicified diorite with almost no sulfides.
468.3	472.1	Silicified diorite with 5 percent arsenopyrite. Gouge at center of interval.
472.1	476.0	Silicified and altered diorite, with trace arsenopyrite and chalcopyrite.
476.0	484.5	Same, with 3-5 percent arsenopyrite and trace chalcopyrite.
484.5	489.1	Same. Top 0.5 foot very highly altered. Next 0.7 foot much less altered. Trace arsenopyrite and pyrite.
489.1	498.0	Same. Bottom of interval slightly darker and less altered. One-2 percent arsenopyrite, 1-2 percent chalcopyrite.

See footnote at end of table.

TABLE 5. - Log of Bureau of Mines diamond-drill hole 1--continued[1/]

Depth, feet from	Depth, feet to	Formations
498.0	500.5	Same, no sulfides.
500.5	504.0	Same, 3-4 percent arsenopyrite, 1 percent chalcopyrite.
504.0	506.7	Diorite, fairly fresh with some unaltered biotite. No sulfides.
506.7	514.0	Silicified diorite, with several vugs filled with quartz crystals. Trace arsenopyrite and chalcopyrite.
514.0	519.0	Silicified and altered diorite, with 5-10 percent chalcopyrite in top 1-2 feet of interval. Barren throughout rest of interval except for traces of disseminated arsenopyrite.
519.0	524.0	Same, 1-2 percent chalcopyrite, 1 percent pyrite.
524.0	534.3	Same, some vugs of quartz and calcite. Three percent chalcopyrite, 2 percent arsenopyrite, 3 percent pyrite.
534.3	539.6	Silicified diorite, with trace disseminated sulfides.
539.6	543.6	No recovery.
543.6	548.0	Diorite, less altered, darker in color, trace arsenopyrite.
548.0	552.2	Same, some parts show unaltered biotite and feldspar, no sulfides.
552.2	555.0	Silicified diorite, with some pyrite.
555.0	560.0	Silicified and altered diorite. No sulfides.
560.0	564.0	Same, but some portions unaltered. Trace disseminated chalcopyrite.
564.0	566.4	Diorite, little altered, dark gray with sugary texture. Trace disseminated sulfides.
566.4	567.4	Diorite, with trace disseminated pyrite and chalcopyrite.
567.4	572.1	Altered and silicified diorite, with trace disseminated pyrite and chalcopyrite.
572.1	580.0	Do.
580.0	584.2	Same, with very small trace of disseminated arsenopyrite.
584.2	590.8	Same, with 1-2 percent arsenopyrite, 1 percent chalcopyrite.
590.8	595.0	Same, with trace disseminated chalcopyrite and arsenopyrite.
595.0	604.7	Same, with trace disseminated chalcopyrite. Some unaltered diorite in lower 1-2 feet of interval.
604.7	606.0	Silicified diorite, traces chalcopyrite and pyrite.
606.0	607.0	Fault breccia with kaolinized feldspars, silica cement. Contains arsenopyrite and pyrite in fine disseminations up to 1 percent.
607.0	614.0	Same, but slightly less silicified with less sulfides.
614.0	622.1	Bleached, silicified diorite with quartz veinlets up to 0.5 inch with chalcopyrite from traces to 0.3 percent, arsenopyrite in scattered cubes.
622.1	627.0	Altered diorite and silicic vein material locally with vuggy quartz, euhedral arsenopyrite to 3 mm in vugs as latest material.

See footnote at end of table.

TABLE 5. - Log of Bureau of Mines diamond-drill hole 1--continued[1/]

Depth, feet from	to	Formations
627.0	636.0	Same, but with less alteration, less sulfides.
636.0	638.0	Vuggy quartz with highly altered diorite, pyrite going to limonite and disseminated chalcopyrite less than 0.2 percent, no sulfides in vugs.
638.0	645.2	Same, with chalcopyrite to 1 percent.
645.2	657.0	Same, but with bornite in crystals to 0.7 cm, chalcopyrite to 0.5 percent.
657.0	669.0	Silicified, bleached diorite, with chalcopyrite in masses to 1.5 cm, arsenopyrite in scattered cubes.
669.0	674.6	Highly kaolinized diorite with traces pyrite, calcite (from feldspars?) complete loss of ferromagnesian minerals shows loss of Mg, Fe.
674.6	720.0	Less altered diorite with hornblende phenocrysts to 1 mm, traces chalcopyrite.
720.0	755.0	Do.
755.0	761.0	Diorite, kaolinized with traces sulfides with some in veinlets of calcite, dolomite to 0.5 mm thick.
761.0	765.0	Very poor core recovery, probably extreme kaolinization.
765.0	767.0	Diorite, light gray with biotite flakes to 1 mm, no sulfides.
767.0	775.5	Diorite, kaolinized with calcite, dolomite veinlets, no sulfides.
775.5	776.0	True fault gouge, with no sulfides.
776.0	788.0	Diorite slightly altered with biotite to 3 mm, disseminated chalcopyrite and pyrite, with some arsenopyrite, less than 0.5 percent.
788.0	796.0	Diorite, fairly fresh with labradorite phenocrysts to 4 mm, hornblende phenos to 3 mm and some biotite, few disseminations bornite and chalcopyrite less than 0.1 percent.
796.0	802.0	Diorite, kaolinized with traces sulfides, veinlets of calcite, dolomite, and silica.
802.0	811.5	Diorite, moderately altered with biotite flakes and finely disseminated chalcopyrite, limonite spots (probably from magnetite after hornblende).
811.5	817.0	Clayey gouge with fragments of kaolinized diorite.
817.0	822.0	Bleached diorite with masses of finely crystalline chalcopyrite to 1.5 cm, total sulfides less than 0.3 percent.
822.0	840.0	Bleached diorite grading downward into fresh diorite with biotite.
840.0	847.0	Unaltered diorite.
847.0	861.0	Kaolinized diorite with very few specks of chalcopyrite.
861.0	863.0	Moderately altered diorite.

See footnote at end of table.

TABLE 5. - Log of Bureau of Mines diamond-drill hole 1--continued[1/]

Depth, feet from	to	Formations
863.0	885.0	Diorite, strongly bleached, kaolinized with few chalcopyrite specks.
885.0	950.0	Fairly fresh diorite, with biotite, contains coatings of microcrystalline chalcopyrite on fine fractures (less than 0.05 percent).
950.0	953.0	Core loss, probably highly kaolinized diorite.
953.0	963.0	Fairly fresh diorite.
963.0	974.0	Diorite, bleached, kaolinized, no sulfides.
974.0	974.4	Vein quartz and dolomite with arsenopyrite in cubes to 1.5 cm, very little chalcopyrite. Total sulfides less than 20 percent.
974.4	1000.0	Fresh diorite.
1000.0	1022.0	Diorite, extremely kaolinized, locally containing quartz veinlets and secondary quartz grains, very few arsenopyrite cubes.
1022.0	1025.0	Gouge of kaolinized diorite, barren.

1/ 0.0 to 455.0 feet logged by W. S. Twenhofel, Geologist, Federal Geological Survey. Remainder of hole 1 logged by John C. Reed, Jr., Geologist, Federal Geological Survey.

TABLE 6. - Petrographic analyses of selected specimens from diamond-drill hole 1[1/]

Sample	Petrographic analyses
Typical diorite.	The rock consists essentially of plagioclase feldspar, of the composition of andesine-labradorite (An 45-55 percent) in phenocrysts up to 7 mm, and hornblende as the chief ferromagnesian mineral. The ground mass is anhedral plagioclase. Accessory minerals are sphene and apatite with approximately 1 percent of biotite which is not derived from hornblende. The plagioclase phenocrysts show strong zoning with an anorthite range of 15-20 percent between cores and rim, although a second type of plagioclase phenocrysts smaller than the zoned ones are not zoned. These later phenocrysts are all less basic than An 45 percent or andesine. Small fractures crossing the rock contain minute crystals of calcite and sericite. The feldspars at the cracks are slightly altered to sericite, kaolin, and calcite, and a few of the hornblende and biotite crystals are altered to magnetite. In the whole, the fresh rock is typical, unaltered diorite containing no free quartz and a dominance of calcic plagioclase over ferromagnesian minerals. In fact, the plagioclase comprises about 70-80 percent of the rock and indicates a magma abnormally rich in calcium with respect to ferromagnesian minerals. In this respect the rock differs from many diorites, and may represent a granitic magma which has been contaminated by limestone syntexis.
Specimen, 120 feet.	This core section contains phenocrysts of feldspar, biotite in a fine-grained matrix of feldspar, quartz, sericite, and calcite. The sericite and calcite have been introduced and replaced the feldspars. Plagioclase is the chief feldspar and also the main mineral with negligible orthoclase. The core section contains approximately 60 percent feldspar, 20 percent biotite, 15 percent quartz, and 5 percent other minerals including a minor amount of pyrite. On the basis of this composition, the sample is classified as porphyritic quartz-diorite.
Specimen, 177 feet.	This core sample contains quartz as the main constituent with some feldspar. Arsenopyrite is the main sulfide with chalcopyrite and minor sphalerite. In addition to the sulfide minerals considerable sericite mica and dolomite have been formed by the mineralizing solutions.

1/ Petrographic analyses of typical diorite specimen from hole No. 1 made by C. L. Sainsbury, Geologist, Federal Geological Survey. All other petrographic analyses were made in Bureau of Mines laboratories at Salt Lake City and Albany, Oreg.

TABLE 7. - Log of Bureau of Mines diamond-drill holes 2, 3, and 4[1/]

Hole No.	Depth, feet from	to	Formations
2	0.0	90.8	Diorite, kaolinized diorite in all stages of alteration, very little silicification, few azurite and malachite stains and traces of chalcopyrite.
2	90.8	210.0	Fault gouge and breccia, contains highly kaolinized fragments of diorite, vein fragments, and secondary dolomite. Many small shears, 45° to hole, talc coated. Some limonite-stained fractures with scattered bornite and hematite.
2	210.0	220.0	Kaolinized diorite.
2	220.0	230.0	Fault gouge with black, sooty oxide probably pyrolusite.
2	230.0	240.0	Light gray diorite partly bleached and kaolinized with hole loss indicating fault gouge.
2	240.0	250.0	Hole loss, probably fault gouge.
2	250.0	299.0	Fault gouge and breccia, traces of chalcopyrite.
2	299.0	309.0	Diorite, partly altered, barren.
2	309.0	356.0	Fault gouge and breccia containing shale fragments. Shears at all angles to hole with slickensided talc. Traces of chalcopyrite on limonite-stained shears.
2	356.0	373.0	Dark gray fault breccia fragments of diorite with introduced calcite and chert fragments, scattered chalcopryite throughout, but less than 0.1 percent in any 1-foot section.
3	0.0	21.6	Limonite-stained fault breccia and gouge containing hematite on fractures. Some pyrolusite.
3	21.6	22.0	Vein breccia with sulfide veinlet 0.25 to 0.5 inch containing marcasite, pyrite, and bornite. Bornite is altering to native copper and covellite.
3	22.0	129.0	Fault breccia, locally spotted with pyrite going to limonite. Some chert fragments and chalcedony and calcite introduced, completely kaolinized diorite fragments. Hole for entire length was in a fault zone which had been silicified and dolomitized with bleaching of ferromagnesian minerals of the wall rock diorite. Sedimentary fragments in fault breccia indicate the diorite is underlain by sedimentary rocks.
4	0.0	35.0	Hole for entire length is in extremely fine-grained argillite which has been silicified and pyritized slightly. Rock is so fine that high magnification of thin section shows only remnant plagioclase fragments largely altered to silica, embedded in a cryptocrystalline ground mass of quartz. One microfossil in the thin section shows that the rock may have been much more limey than at present, and the lime may have been replaced by silica. Hole shows no recognizable bedding, but contains areas of a residual sandy material consisting largely of quartz grains. Sulfide mineralization consists entirely of pyritization.

1/ Logged by John C. Reed, Jr., Geologist, Federal Geological Survey.

TABLE 8. - Spectrographic analyses of selected specimens of diamond-drill cores

Hole No.	1	1	1	1	1	1	1	1	1	2	2	2	2	2	3	3	3	4
Footage																		
From	0.0	159.5	291.0	455.0	504.0	669.0	776.0	840.0	953.0	0.0	90.8	210.0	299.0	356.0	0.0	21.6	22.0	0.0
To	159.5	291.0	455.0	504.0	669.0	776.0	840.0	953.0	1025.0	90.8	210.0	299.0	356.0	373.0	21.6	22.0	129.0	35.0
Element:																		
Aluminum.	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Antimony.	-	D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic..	-	D	D	D	D	-	-	-	D	-	-	-	-	-	-	-	-	-
Barium...	D	D	D	D	D	D	D	D	D	D	E	E	E	E	E	E	E	D
Bismuth..	-	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Boron....	F	E	E	E	E	E	F	F	F	E	F	F	F	F	F	F	F	F
Calcium..	B	C	A	B	C	A	A	B	B	D	C	C	A	A	A	A	A	B
Chromium.	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Cobalt...	-	-	-	E	F	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper...	F	C	E	D	E	F	F	E	F	F	F	F	F	F	F	D	F	G
Iron.....	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Lead.....	E	D	E	E	E	E	E	-	E	-	-	-	-	-	E	E	E	-
Magnesium	B	B	B	B	B	B	B	B	B	C	C	C	B	B	C	C	B	B
Manganese	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Molybdenum...	D	E	E	E	E	E	E	E	E	F	F	F	F	F	F	F	E	E
Nickel...	D	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E
Silicon..	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
Sodium...	D	D	D	D	D	D	D	D	D	E	E	D	D	D	E	E	E	C
Tin......	-	E	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Titanium.	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C	C
Vanadium.	D	D	D	E	D	D	D	D	D	D	D	D	D	D	D	D	D	D
Zinc.....	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	E	-	-
Zirconium	E	E	E	E	E	E	E	E	E	E	E	E	E	E	E	F	F	F

A--More than 10 percent.
B--5 to 10 percent.
C--1 to 5 percent.
D--0.1 to 1 percent.
E--0.01 to 0.1 percent.
F--0.001 to 0.01 percent.
G--Less than 0.001 percent.

Elements tested but not detected were: Beryllium, cadmium, gallium, germanium, hafnium, mercury, indium, iridium, lithium, osmium, phosphorus, palladium, platinum, rhenium, rhodium, strontium, tantalum, tellurium, thallium, and tungsten.

TABLE 9. - Weighted average analyses of sections of diamond-drill holes 1 and 2

Sample No.	Core				Sludge				Weighted average		
	Weight grams	Percent copper	Ounce gold	Ounce silver	Weight grams	Percent copper	Ounce gold	Ounce silver	Percent copper	Ounce gold	Ounce silver
				Representative section of diamond-drill hole 1							
22	700	0.05	<0.01	0.5	3,030	0.29	0.12	0.8	0.24	0.10	0.70
23	1,095	.07	.72	2.5	1,990	.22	.24	1.1	.17	.41	1.6
24	1,214	.04	<.01	.6	2,660	.14	.22	1.2	.12	.15	1.0
25	2,165	.11	.02	.7	5,050	.14	.18	.9	.13	.13	.8
26	590	.09	<.01	.4	3,701	.12	.10	.6	.12	.09	.6
27	1,416	.07	.02	.4	2,640	.10	.06	.5	.09	.05	.5
28	1,335	.05	<.01	.3	4,171	.12	.18	1.0	.10	.14	.8
29	557	.07	.02	.6	2,910	.12	.24	1.1	.11	.20	1.0
30	810	.11	<.01	.5	5,571	.07	.24	1.2	.08	.21	1.1
31	252	.09	<.01	.5	4,790	.10	.22	1.1	.10	.21	1.1
32	1,381	.05	<.01	.4	2,650	.10	.34	.9	.08	.23	.7
33	1,405	.07	<.01	.3	2,451	.14	.18	1.2	.11	.11	.9
34	1,115	.11	<.01	.4	1,740	.12	.17	1.4	.12	.10	1.0
35	1,240	.09	<.01	.4	2,550	.12	.15	1.4	.11	.10	1.1
				Representative section of diamond-drill hole 2							
E-27	974	.05	<.01	.4	4,800	.05	.02	.6	.05	.07	.6
E-41	1,023	.07	<.01	.4	6,080	.05	<.01	.4	.05	<.01	.4
E-42	482	.09	<.01	.3	6,500	.07	.01	.6	.07	.01	.6
E-43	3,440	.09	.01	.5	7,790	.09	.01	.5	.09	.01	.5

TABLE 10. - Core and sludge recovery, diamond-drill holes 1, 2, and 3[1]

Sample No.	Footage from	Footage to	Core percent	Sludge[2] percent	Sample No.	Footage from	Footage to	Core percent	Sludge[2] percent
1	140.0	146.0	75	No data	47	364.0	367.1	80	No data
2	146.0	154.8	59	No data	48	367.1	371.2	76	No data
3	154.8	156.5	85	No data	49	371.2	376.0	100	No data
4	156.5	165.5	57	No data	50	376.0	381.0	100	No data
5	165.5	175.5	26	No data	51	381.0	384.0	30	No data
6	175.5	180.5	51	No data	52	384.0	386.0	70	No data
7	180.5	185.5	26	No data	53	386.0	391.0	8	No data
8	185.5	190.5	8	No data	54	391.0	396.0	12	No data
9	190.5	195.5	56	No data	55	396.0	401.0	47	No data
10	195.5	200.5	94	No data	56	401.0	404.1	94	No data
11	200.5	205.4	78	No data	57	404.1	408.6	49	No data
12	205.4	209.0	80	No data	58	408.6	409.6	100	No data
13	209.0	213.0	98	No data	59	409.6	412.6	97	No data
14	213.0	218.0	100	No data	60	412.6	416.0	68	No data
15	218.0	223.0	100	No data	61	416.0	418.3	96	No data
16	223.0	228.0	78	No data	62	418.3	423.5	62	No data
17	228.0	233.0	38	No data	63	423.5	426.0	18	No data
18	233.0	238.0	65	No data	64	426.0	430.2	77	No data
19	238.0	243.1	74	No data	65	430.2	435.1	63	No data
20	243.1	248.1	37	No data	66	435.1	440.1	58	No data
21	248.1	253.0	39	No data	67	440.1	445.1	32	No data
22	253.0	258.1	38	No data	68	445.1	450.1	25	No data
23	258.1	261.0	93	No data	69	450.1	455.0	20	No data
24	261.0	265.8	51	No data	70	455.0	460.0	48	No data
25	265.8	271.0	86	No data	71	460.0	464.2	48	No data
26	271.0	276.0	40	No data	72	464.2	466.0	100	No data
27	276.0	281.0	68	No data	73	466.0	468.2	19	No data
28	281.0	286.0	53	No data	74	468.2	472.3	22	No data
29	286.0	291.0	32	No data	75	472.3	476.0	55	No data
30	291.0	296.0	33	No data	76	476.0	481.0	36	No data
31	296.0	301.0	13	No data	77	481.0	484.5	47	No data
32	301.0	306.0	56	No data	78	484.5	489.1	65	No data
33	306.0	309.0	58	No data	79	489.1	498.0	33	22
34	309.0	311.4	100	No data	80	498.0	500.5	24	73
35	311.4	316.4	47	No data	81	500.5	504.0	46	59
36	316.4	321.4	50	No data	82	504.0	506.5	30	66
37	321.4	326.4	50	No data	83	506.5	514.0	71	32
38	326.4	331.3	30	No data	84	514.0	519.0	78	39
39	331.3	336.2	74	No data	85	519.0	524.0	34	40
40	336.2	341.0	33	No data	86	524.0	534.3	48	52
41	341.0	346.0	56	No data	87	534.3	539.6	40	57
42	346.0	350.0	69	No data	88	539.6	543.6	0	105
43	350.0	355.0	48	No data	89	543.6	548.0	25	94
44	355.0	359.7	59	No data	90	548.0	552.2	31	137
45	359.7	362.0	83	No data	91	552.2	555.0	13	43
46	362.0	364.0	70	No data	92	555.0	560.0	30	40

See footnotes at end of table.

TABLE 10. - Core and sludge recovery, diamond-drill holes 1, 2, and 3[1]--continued

Sample No.	Footage from	Footage to	Core percent	Sludge[2] percent	Sample No.	Footage from	Footage to	Core percent	Sludge[2] percent
93	560.0	564.0	38	65	138	850.5	855.5	16	79
94	564.0	566.4	83	68	139	855.5	860.5	90	51
95	566.4	567.5	100	64	140	860.5	865.5	67	22
96	567.4	572.7	36	59	141	865.5	870.5	40	77
97	572.7	580.0	47	36	142	870.5	875.5	22	70
98	580.0	584.2	40	68	143	875.5	880.5	70	52
99	584.2	590.8	17	42	144	880.5	885.5	26	79
100	590.8	595.0	36	18	145	885.5	890.5	70	95
101	595.0	604.8	22	82	146	890.5	895.5	34	108
102-A	604.8	614.8	31	58	147	895.5	900.5	30	104
102-B	614.8	622.0	24	47	148	900.5	905.5	22	121
103	622.0	627.1	31	88	149	905.5	910.5	14	110
104	627.1	638.0	30	59	150	910.5	915.5	30	90
105	638.0	648.2	6	74	151	915.5	920.5	26	84
106	648.2	658.0	11	62	152	920.5	924.7	21	154
107	658.0	669.6	12	55	153	924.7	930.0	51	106
108	669.6	674.6	50	59	154	930.0	935.0	14	149
109	674.6	683.0	12	195	155	935.0	940.0	12	129
110	683.0	693.0	10	89	156	940.0	945.0	20	224
111	693.0	703.0	6	125	157	945.0	950.0	10	171
112	703.0	709.1	5	123	158	950.0	955.0	60	197
113	709.1	717.0	7	88	159	955.0	960.0	30	212
114	717.0	720.0	10	225	160	960.0	965.0	58	158
115	720.0	725.8	11	112	161	965.0	970.0	52	167
116	725.8	731.9	5	148	162	970.0	975.0	16	149
117	731.9	734.3	25	199	163	975.0	980.0	26	229
118	734.3	741.1	15	78	164	980.0	985.0	24	128
119	741.1	751.1	3	108	165	985.0	990.0	30	165
120	751.1	755.1	15	193	166	990.0	995.0	46	196
121	755.1	761.6	20	41	167	995.0	1000.0	38	120
122	761.6	767.0	35	68	168	1000.0	1005.0	66	97
123	767.0	777.0	45	70	169	1005.0	1010.0	90	70
124	777.0	787.0	63	82	170	1010.0	1015.0	98	104
125	787.0	792.0	68	86	171	1015.0	1020.0	50	90
126	792.0	797.0	30	148	172	1020.0	1025.0	98	106
127	797.0	802.0	60	74	E-27	275.0	280.0	100	96
128	802.0	807.0	64	69	E-41	315.0	320.0	56	122
129	807.0	812.0	22	86	E-42	320.0	329.7	12	67
130	812.0	817.0	50	43	E-43	329.7	339.7	75	78
131	817.0	822.0	14	70	S- 2	44.0	49.0	1	105
132	822.0	825.5	31	131	S- 3	49.0	53.0	9	107
133	825.5	830.5	18	126	S- 4	53.0	54.1	13	145
134	830.5	835.5	38	90	S- 5	54.1	59.1	4	86
135	835.5	840.5	22	82	S- 6	59.1	64.0	3	190
136	840.5	845.5	56	92	S- 7	64.0	66.0	0	106
137	845.5	850.5	46	54	S- 8	66.0	71.0	0	127

See footnotes at end of table.

TABLE 10. - Core and sludge recovery, diamond-drill holes 1, 2, and 3[1/]--continued

Sample No.	Footage from	Footage to	Core percent	Sludge[2/] percent	Sample No.	Footage from	Footage to	Core percent	Sludge[2/] percent
S- 9	71.0	76.0	2	131	S-17	109.0	114.0	2	134
S-16	104.0	109.0	1	105	S-18	114.0	119.0	1	149

1/ Samples 1 to 172 are from hole 1. Sample numbers preceded by "E" are from hole 2. Sample numbers preceded by "S" are from hole 3. Core and sludge samples having the same numbers are from the same place.

2/ Percent sludge recovery is percent of theoretical weight of sludge having the same average specific gravity as the core. Therefore, overruns of sludge may indicate either heavier material recovered as sludge or an abnormally large amount of material of the same specific gravity as the core. Underruns can only indicate loss of part of the sample.

Ore Beneficiation

The Ore

Channel samples from the Golden Zone mine workings, each weighing from 35 to 40 pounds, were crushed and split to obtain representative samples for chemical analyses. The rejects were composited to provide metallurgical samples. A straight composite of channel samples 31 to 41, inclusive (fig. 7), represented the ore exposed on the 100 level; a similar composite of channel samples 6 to 24, inclusive (fig. 8), represented the 200 level.

Physical Character

Petrographic study showed that the 100 level sample consisted of arsenopyrite, chalcopyrite, and relatively small amounts of sphalerite, cerussite, pyrite, and traces of smithsonite which occurred associated with sericite, quartz, a magnesian-bearing calcite, and small amounts of limonite and chlorite. The 200 level sample was similar except for the lack of sphalerite and the considerably lesser amount of chalcopyrite. A portion of the chalcopyrite in this sample was tarnished with an iridescent coating.

Microscopic examination showed that most of the sulfides in both samples are unlocked in the minus 65- plus 100-mesh fraction, but grinding through 100-mesh was required to provide optimum liberation.

Chemical Character

Representative head samples, prepared from the composites, were analyzed chemically; results of the analyses are given in table 11.

A semiquantitative spectrographic analysis of representative portions of the samples revealed the presence and approximate amounts of metals listed in table 12. Any other elements present were in quantities lower than the minimum detectable by the routine method employed.

TABLE 11. - Chemical analyses

	Assay, percent						
	Copper	Lead	Zinc	Insoluble	Antimony	Arsenic	Iron
100 level......	0.97	<0.05	0.32	62.6	<0.1	4.1	10.4
200 level......	.24	<.05	<.05	64.0	<.1	14.9	9.5

	Ounces per ton	
	Gold	Silver
100 level......	0.18	3.4
200 level......	.23	1.25